Recommended Futurebus+ Module Assembly Process

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ABSTRACT: This document provides the recommended module assembly and repair process for the FB+ B2999 module, Profile B corner design in conjunction with the Futurebus FB+ Technical Program Office (TPO), FB+ design must meet Electronic Industries Association (EIA) standards. This report also highlights all development activities that have gone into each planning stage of the recommended process.

APPLICABILITY: All or parts of the recommended module assembly process may be used by the manufacturing plants. The recommended process will highlight general requirements, as well as specialized FB+ equipment or processes needed for assembling components on the FB+ B2999, such as handle, through-hole, and SMT series modules.

STATUS: APPROVED 05-Mar-1992; use VTX SMC for current status.

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1 SCOPE

All or parts of the recommended module assembly process may be used by the manufacturing plants. The recommended process will highlight general requirements, as well as specialized Futurebus+ (FB+) equipment or processes needed for assembling components on the FB+ B2999, such as handle, through-hole, and surface mount (SMT) series modules.

The recommended assembly process is bounded by its entry into screenprinting through component placement, reflow, cleaning, hand assembly, and final repair.

This document does not provide detailed information for module assembly equipment such as equipment settings, I/R profiling, equipment placement accuracy, and so forth, due to the present disparity of module assembly equipment between manufacturing sites.

2 INTRODUCTION

This document provides manufacturing plants with a recommended module assembly process for the FB+ Profile B corner design layout. The entire recommended module assembly process was reviewed, from screenprinting through final assembly. All new assembly processes and equipment required for FB+ were fully characterized, using Design of Experiments and Six Sigma goals, wherever possible. All other process steps contain the necessary requirements for successfully building and repairing FB+ modules.

The FB+ design uses new technology, such as metric pitch surface mount devices and connectors, which call for new assembly process requirements that directly affect plant manufacturing procedures. Therefore, a major effort was put forth to ensure that future FB+ module manufacturing sites would be ready to support this build once FB+ product reaches the plants.

To ensure a smooth transition into manufacturing, an FB+ Assembly Team was formed. This team consisted of development and manufacturing engineers, within various module manufacturing and development sites. The Assembly Team worked collectively, linked together by means of a weekly Module Assembly Forum. Team members were chosen for their closeness to manufacturing process, modules skills/knowledge, and product ties. The Module Assembly Forum goal was three-fold:

1. Discuss any module assembly issues or concerns associated with the FB+ module layout design and assign action items for resolution. Concurrently, performing Design for Manufacturing (DFM) activities with the module layout/signal integrity team to ensure a good corner design for assembly.
2. Discuss individual FB+ development project status and to employ the team's diverse skills and knowledge to improve on project success. In other words, the Forum acted as a continuous peer review. Any, and all, development reports were reviewed and critiqued by team members first, to ensure that manufacturing interests were covered.
3. Provide a communication link between the various FB+ module manufacturing sites. It is critical that FB+ manufacturing sites be prepared early, especially when considering implementation of new equipment and processes. The weekly meetings were open to all individuals and FB+ product groups for discussions of action items.

2.1 ASSEMBLY TEAM

The final outcome of this report is a collective agreement between the plant and product representatives involved as Module Assembly Team members. I would like to thank each and every one of the Assembly Team members for participation and contributions to this effort. The representatives include:

Roy Batchelder	TME Producibility Engineering	COBRA
Janak Brahmbhatt	DAS Customer Logistics	Digital Services
George Chilek	ASO Manufacturing	PYTHON
Helen Cullinane	GAO Manufacturing	LASER
Bob Dumais	ASO Process Engineering	PYTHON
Viorica Florescu	KAO CTC Development Engineer	FB+
Nick Gildred	ASO Manufacturing Engineering	PYTHON
Ben Heydary	NIO COM Development Engineer	FCA
Michele Jones	AYO Process Engineering	COBRA
Alasdair Lewis	AYO Stage I Engineering	COBRA
Dave Mammone	MLO TME Module Assembly Engineer	LASER
Ivan McLaughlin	KLO/GAO Manufacturing Engineer	HASTINGS
F. James McWilliams	NIO LEMSB NP Engineer	
Jim Rowan	AYO Module Assembly Engineering	COBRA
Ed Ruane	KLO Process Engineering	HASTINGS

2.2 BACKGROUND

Within the beginning stages of FB+ module assembly development, numerous design and component issues stood out as needing development, evaluation, or some sort of verification to ensure manufacturability. The 2 mm connector was one such area needing development work, mainly due to differences in its pin field pattern (2-mm or .079 inch versus .100 inch), nominal plated through-hole (PTH) size (.030 inch versus .038 inch), and fastening method (heatstake versus screw). These differences created various process-related issues in assembly, soldering, repair, and so forth.

When the Module Assembly Development project was initiated, some FB+ development activities were already in process, such as heatstake process characterization, localized connector assembly and repair processes, and wave solder characterization. These activities were initially part of the FB+ interconnect development work (Cliff Lupien, Project Manager) and transferred over when the Module Assembly Project was initiated.

Remaining SMT development work was added to the project and executed in two module manufacturing sites (AYO and ASO). Confirmation trials of the entire module assembly process were performed at MLO.

Smaller FB+ module issues were worked within the weekly FB+ Forum, by team members. At times, team members performed selective experiments and evaluations to prove assembly methods. Manufacturing issues that were better solved through design changes, were brought back to FB+ Routing and Bus Corner implementation meetings for resolution.

3 FB+ B2999 MODULE

3.1 MODULE LAYOUT

This document reflects FB+ B2999_00_B01, Profile B module (Figure 1) consisting of the following technology for 128-bit option:

B2999 board outline, as defined in *B-Futurebus+, B2000 Series Module Connector, Detail and Circuit Outline* drawing no. D-MD-ELEN654-0-DBU. This drawing, when released, will be available in *PC Board Engineering Handbook - Standard Circuit and Finger Details*, order number EL-ENPCB-01.

- Finished board size
  289.35 mm (11.392 inch) × 264.85 mm (10.427 inch) ± 0.15 mm (.006 inch)
- Thickness 2.29 mm (0.090 inch)
- Connector
  PTH 0.76 mm (.030 inch ±.003 inch) inner diameter
  pad 1.27 mm (.050 inch) diameter

3.2 COMPONENTS

Double-sided (actives and passives) surface mount components;

- 52-pin Plastic Quad Flat Packs (PQFP), .65 mm (25.6 mil) pitch, gull wing, (quantity 12) side 1, (quantity 11) side 2
- Case D tantalum polarized bulk capacitor, (quantity 1) side 1
- Decoupling capacitors (with side termination), (quantity 29) side 1, (quantity 30) side 2
- Resistors (discretes), (quantity 20) side 1, (quantity 14) side 2
- 16-pin, 50-mil, glitch filter (SOIC), (quantity 1) side 1
- 3-pin test connector

Single-sided through-hole components;

- 2-mm, 4-row, intrusive pin power and signal connectors, modular type, (quantity 2) 4 × 48 signal (1) 4 × 6 signal (4) 4 × 2 power, side 1
- LEDs, red and green, (quantity 1 each) side 1

Bulkhead (handle) assembled with eyelets (4 locations), (quantity 1)

Refer to Futurebus Control Drawing A-SP-B2999-00-0 for module layout.

NOTE

Layout for 64-bit and 32-bit options are also available.

3.3 MODULE FILES

B2999_00_B01.DDF;1
B2999_00_B01_ARTCHK_L01.GER;1
B2999_00_B01_ARTCHK_L02.GER;1
B2999_00_B01_ARTCHK_L03.GER;1
B2999_00_B01_ARTCHK_L04.GER;1
B2999_00_B01_ARTCHK_L05.GER;1
B2999_00_B01_ARTCHK_L06.GER;1
B2999_00_B01_ARTCHK_L07.GER;1
B2999_00_B01_ARTCHK_L08.GER;1
B2999_00_B01_ARTCHK_L09.GER;1
B2999_00_B01_ARTCHK_L10.GER;1
B2999_00_B01_ARTCHK_SM1.GER;1
B2999_00_B01_ARTCHK_SM2.GER;1
B2999_00_B01_ARTCHK_SP1.GER;1
B2999_00_B01_ARTCHK_SP2.GER;1
B2999_00_B01_ART_APRDESC.TXT_RPT;1
B2999_00_B01_ART_HOLE_ALL.GRB;1
B2999_00_B01_ART_HOLE_ALL.APRDESC.TXT_RPT;1
B2999_00_B01_ART_L01.GRB;1
B2999_00_B01_ART_L02.GRB;1
B2999_00_B01_ART_L03.GRB;1
B2999_00_B01_ART_L04.GRB;1
B2999_00_B01_ART_L05.GRB;1
B2999_00_B01_ART_L06.GRB;1
B2999_00_B01_ART_L07.GRB;1
B2999_00_B01_ART_L08.GRB;1
B2999_00_B01_ART_L09.GRB;1
B2999_00_B01_ART_L10.GRB;1
B2999_00_B01_ART_SM1.GRB;1
B2999_00_B01_ART_SM2.GRB;1
B2999_00_B01_ART_SP1.GRB;1
B2999_00_B01_ART_SP2.GRB;1
B2999_00_B01_DES_PART.PLS;1
B2999_00_B01_DRLCHK_PWB.GER;1
B2999_00_B01_HOLE_ALL.EXC;1
B2999_00_B01_HOLE_ALL_RPT.TXT_RPT;1
B2999_00_B01_HOLE_ALL_XYRPT.TXT_RPT;1
B2999_00_B01_MODULE.ADS;1
B2999_00_B01_TEST_CONT.CTF;1
B2999_00_B01_TEST_RES.RTF;1
D_MD_ELEN648_0_DBU_B_01.PLO;1
D_MD_ELEN654_0_DBU_B_01.PLO;1
E_SP_B2999_0_0_B_01.PLO;2
E_SP_B2999_0_0_B_02.PLO;2
E_SP_B2999_0_0_B_03.PLO;2
E_SP_B2999_0_0_B_04.PLO;2
E_SP_B2999_0_0_B_05.PLO;2
E_SP_B2999_0_0_B_06.PLO;2
E_SP_B2999_0_0_B_07.PLO;2
E_SP_B2999_0_0_B_08.PLO;2
E_SP_B2999_0_0_B_09.PLO;2
E_SP_B2999_0_0_B_10.PLO;2
E_SP_B2999_0_0_B_11.PLO;2
E_SP_B2999_0_0_B_12.PLO;2
E_SP_B2999_0_0_B_13.PLO;2
E_SP_B2999_0_0_B_14.PLO;2
E_SP_B2999_0_0_B_15.PLO;2
E_SP_B2999_0_0_B_16.PLO;2
E_SP_B2999_0_0_B_17.PLO;2
K_CS_B2999_0_0_B_01.PLO;1
K_CS_B2999_0_0_B_02.PLO;1
K_CS_B2999_0_0_B_03.PLO;1
K_CS_B2999_0_0_B_04.PLO;1
K_CS_B2999_0_0_B_05.PLO;1
K_CS_B2999_0_0_B_06.PLO;1
K_CS_B2999_0_0_B_07.PLO;1
K_CS_B2999_0_0_B_08.PLO;1
K_CS_B2999_0_0_B_09.PLO;1
K_CS_B2999_0_0_B_10.PLO;1
K_CS_B2999_0_0_B_11.PLO;1
K_DD_B2999_0_0_B_01.PLO;1
K_PL_B2999_0_DBP_B_01.PLO;1
MSB_PWB_DATA.DOCUMENT;1

3.4 PARTS LIST

Table 1: Parts List

Line Item	Part Number	Description	Quantity	Reference Designator
1	10-30153-01 B	0.082 µF 50 V +80/-20% X 7R CE	43	C2 – C60
2	10-34976-29	100 µF 10 V ±10% GEN PUR	1	C1
3	11-17373-00 A	LED assembly, RTAN single 2 MCD 20 mA	1	D2
4	11-17373-02 A	LED assembly, RTAN single 2 MCD 20 mA	1	D1
5	12-22841-01 B	PCB Header 03 POS(1 X 03).156CC 90D	1	J7
6	12-33430-02	Connector, 4 × 2 power positive	4	J1–J4
7	12-33431-02	connector, 4 × 48 signal positive	2	J6, J8
8	12-33431-04	Single positive, 2 mm connector, receptacle 4 × 6	1	J5
9	13-23825-25 A	100.0, .25 W 5.0 % chip	8	R16, R18, R20, R22, R24, R26, R28, R34
10	13-23825-33	220.0, .25 W 5.0 % chip	2	R13, R14
11	13-23825-50 A	1.10 k, .25 W 5.0 % chip	4	R29–R32
12	13-23825-65	4.70 k, .25 W 5.0 % chip	19	R2–R12, R15, R17, R19, R21, R23, R25, R27, R33
13	13-23826-49 A	1.00 M .25 W 5.0 % chip	1	R1
14	19-35442-01 A	BTL transceiver, 7 B	3	E1,E3,E17
15	19-35444-01 A	BTL transceiver, 8 B	3	E2,E4,E6
16	19-35698-01	Signetics glitch filter	1	E16
17	19-36239-01 A	Transceiver, 9-bit LAT	17	E5, E7–E14, E18–E25
18	90-06745-00	Eyelet, rolled 0.120D 0.260L BRN	4	P1–P4
19	[1]70-28727-01	Bulkhead assembly, generic	1	NA

[1]Generic bulkhead with no I/O opening or LED openings.

Refer to A-SP-B2999-0-0 for other options of eyelets.

3.5 PACKAGING

This segment includes packaging information for parts and components listed under 3.2 to be introduced into Digital's module manufacturing floor for the FB+ module. Any parts and items not listed are assumed to have standard packaging requirements currently existing.

Tranceivers

Dry packed using:

- Metallized ESD protective bags
- Desiccant dryer
- Nitrogen sealed
- RH indicator card

Matrix component ESD trays, quantity 119 components per tray, storage conditions

- 25°C (77°F)
- 80% Relative humidity (RH)
- Baking required after 72 hours exposure. Bake for six hours at 150°C.
  or
  Verify that H_2O content is less than 1000 ppm, if equipment and process is available to perform this function.

Bulk Capacitor, General Purpose

12-mm tape and reel, static-shielded bag

Decoupling Capacitors

8-mm tape and reel, static-shielded bag

Resistors

8-mm tape and reel, static-shielded bag

Glitch Filter

ESD-treated plastic feeder tubes. Tape and reel may be added, if required.
No baking requirements.

2-mm Connector

Antistatic-treated plastic tubes

Sig	Quantity per Tube
4 × 48	6
4 × 6	48
4 × 2	48

LEDs

Static-shielded bag

Front Panel Handle Bulkhead

Packaging has not been fully determined at this time. Contact Mike O'Neil for further details.

3.6 UNIQUE FB+ TRAITS

This section highlights the new or unique parts or conditions or both associated with the FB+ module. Additional information concerning evaluations of these unique traits are listed under head 6, *Design for Manufacturing*.

Tranceivers (FB2030)—Metric .65 mm (25.6 mil) Pitch Leads

New components having metric lead pitch devices that are new to most Digital module manufacturing sites. This feature is not considered to be a major risk with plants, due to existing 25 mil component placement capabilities.

Components have been qualified by Semiconductor Business Operations (SBO) in Franklin (FXO). Contact Rick Spragg (MILKWY::) for qualification report. Refer to *Surface Mount Technology Reference Manual*, order number EL-MF417-01, for component details.

CAUTION

Current transceivers are *extremely ESD-sensitive*. No ESD protection was built into these components. Special care must be used when handling these components.

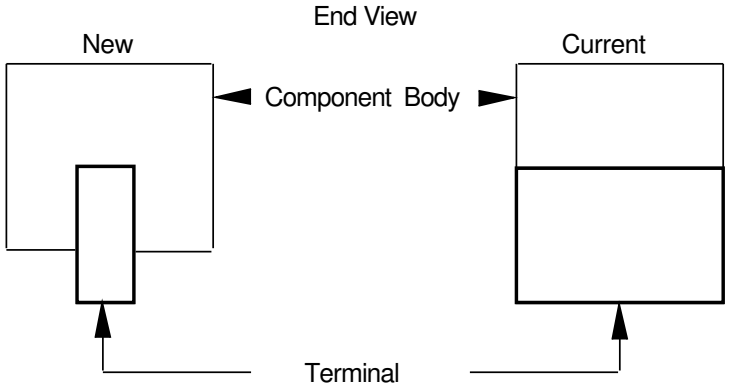
Future revisions FB2031, FB2040, and FB2041 will have ESD protection. These components are due to be qualified in Q4 FY '91.

Glitch Filter (CD3200)—New Component

Glitch filter is packaged as a 16-pin plastic SOIC which is common to manufacturing and poses low risk for assembly. This component is also qualified by SBO. Contacts are the same as mentioned above.

Bulk Capacitor—Center Terminal Strip

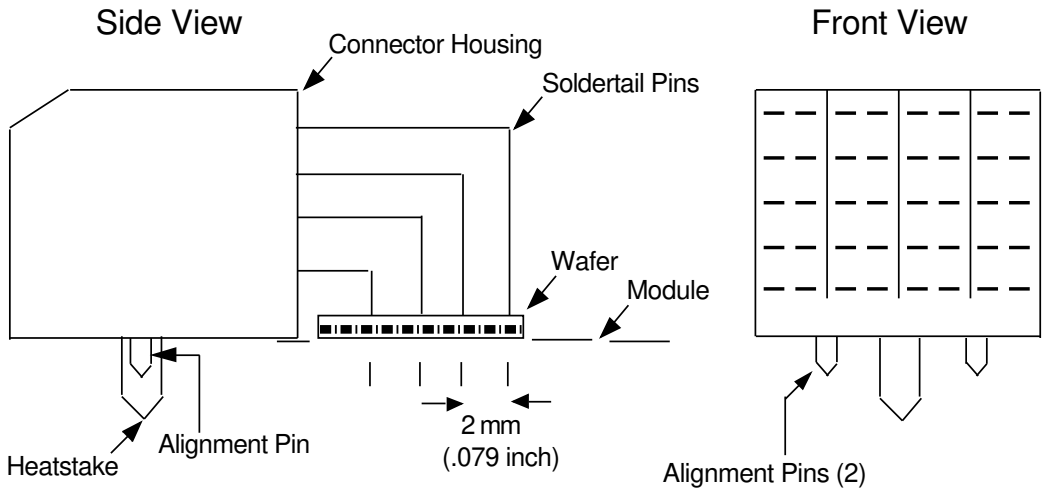
New general purpose capacitor (10-34976-29) has a center termination strip at each end of the component, rather than the current, and more widely used, termination bands that are equal (same) in width, at each end. Refer to subhead 6.1.3. Contact John Shaw, Component Engineer for qualification information.



2-mm Connector—New Fastening Method and New Pin-to-Hole Pattern

The connector fastening system is also new to Digital. The connector is fastened to the module by means of heatstaking. Plastic connector posts are melted with hot punches that form rivets. Refer to subhead 6.1.5.

New right angle intrusive connector has a metric 2 mm (.079 inch) pin-field grid versus the standard .100 inch (center-to-center) pin grid. This PTH and soldertail pin-field pattern is new to Digital. Refer to subhead 6.1.6.



Refer to purchase specifications A-PS-1233430-00-0 through A-PS-1233434-00-0 for dimensional details.

NOTE

Contact Alex Coghill at POLAR::COGHILL of the Canadian Technology Center for any 2 mm connector-related concerns.

Front Panel—Tolerance Requirements

The Electronic Industries Association (EIA) has instituted tight tolerance requirements for the front panel (handle) location. Refer to heading 6.1.11.

Keying—Module-to-Backplane

Basically, what keying does is prevent the insertion of an FB+ module into the wrong backplane slot, by attaching a plastic coded keying system to the module and backplane. The Keying or coding system consists of a plastic blocking piece that is fixed to the backplane connector and a corresponding part that mounts beneath the module connector.

Keying is an EIA FB+ option that Digital chooses not to build at this time. However, mounting holes will be provided on each FB+ module for any future needs.

4 RECOMMENDED MODULE ASSEMBLY and REPAIR PROCESS

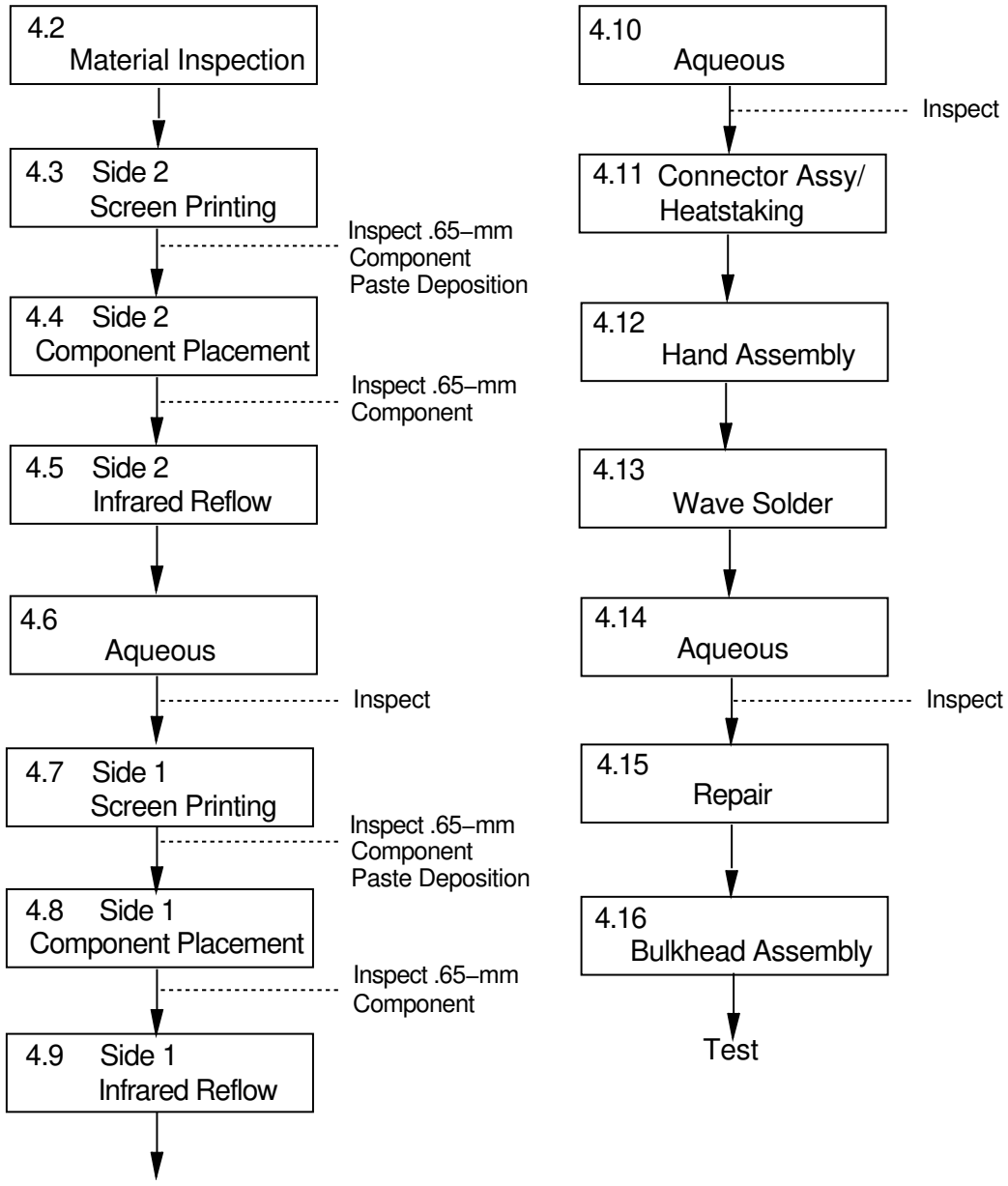
The following sections outline the recommended module assembly process for building a generic B2999 Futurebus+ module. The elements and methods highlighted within this recommended process have been tested and verified using test vehicles at various development sites. The results of experiments, evaluations, characterizations, and verifications were reviewed by the FB+ Assembly Team and determined to be the best method of assembly and repair for this module.

The experiments and characterization work that went into determining this recommended process, incorporated Design for Experiments (D.O.E.) methods and Six Sigma strategy, wherever possible.

This information assumes that all plant handling and process control requirements are followed. Any equipment settings or parameters outlined in these sections are the outcome of test case evaluations and should be used solely as a guideline, unless specified otherwise.

Figure 2 shows the recommended process flow for the FB+ B2999 generic module assembly.

Figure 1: Process Flow Diagram



4.1 MATERIAL INSPECTION

All components should be inspected through normal site incoming inspection procedures. General inspection criteria for new components are outlined below:

4.1.1 Material Requirements

Storage Requirements—25°C (77°F), 80% RH, 72 hours for transceivers or verify H_2O content is less than 1000 ppm, if equipment and process is available.

4.1.2 Process Requirements

Transceivers

19-35442-01, 19-35444-01, and 19-36239-01 are PQFPs consisting of 52-pin, gull-wing, .065 mm (.0256 inch) pitch leads. These components will be inspected using the same criteria as standard 25-mil pitch devices.

Glitch Filter

19-35698-01 inspection standard for 16-pin, 50-mil pitch SOIC package.

2-mm connector

Digital Part No.	Description
12-33431-02	4 x 48 Female signal (.093 inch)
12-33431-04	4 x 6 Female signal (.093 inch)
12-33430-02	4 X 2 Female power (.093 inch)
12-33431-01	4 x 48 Female signal (.062 inch)
12-33431-03	4 x 6 female signal (.062 inch)
12-33430-01	4 x 2 Female power (.062 inch)

Visual Inspection

a. Packaging Quality: Inspect the entire shipment.

Connectors are secured in the tubes.
Soldertails not squeezed or bent.
Wafer is secure on the tails.

Wafer must remain on the tails after three shakes.
Heatstakes are not broken.

b. General Quality: Inspect the contents of one tube.

Wash-out feature is present with the larger stand-off on top row and the smaller stand-off on bottom row.
Soldertail pins not missing
Tin-lead on soldertails not blistering.
Marking is present:

Vendor name
Vendor part number
Date code
Revision

Cavity identification on wafer
Cavity identification on housing

NOTE

Refer to Digital Purchase Specifications for detailed dimensional and plating inspection requirements.

Refer to respective Digital Purchase Specifications for details of other components.

4.2 SCREEN PRINTING (SIDE 2)

This section outlines the recommended requirements for side 2 screen-printing operations of FB+ modules. Assumption: standard screen-printing practices will be followed.

Stencil will be mounted into frame, then mounted in screen printer. Solder paste is deposited on the module by spreading it across a stencil using a squeegee. Hydraulic pressure, created by the leading edge of the squeegee forces solder paste through apertures (openings) that are patterned after the circuit pads and deposited onto the module.

4.2.1 Material Requirements

Paste

Type—Recommended paste parameters include:

Fine grain (25-38 µm particle size)
63/37; Flux type RMA
Tested viscosity: 800 minimum to 900 maximum Kilo-Centipoise (Kcps)
Paste container opened at room temperature

4.2.2 Process Requirements

Stencil

GERBER Files—Solderpaste artwork for side 2 stencil generation may be obtained by importing B2999_00_B01.ART_SP2.GRB;1 file from MSBMDA cluster.

Material—Stainless steel is recommended for durability and extended wear.

Type of Cut—Plant specified (laser, and so forth) according to equipment and process requirements.

Type (Step or Uniform Thickness)—Plant specified according to equipment and process volume requirements for 25-mil pitch devices.

Apertures—Plants should configure stencils and aperture dimensions to meet recommended volume requirements.

- Recommended solder volume for .65-mm pitch transceiver components footprint is 6257 cubic mils. For example:

  Stencil openings using 10/4 step stencil = 12 $\times$ 76 $\times$ 4 mils

  Stencil openings using uniform stencil = 12 $\times$ 70 $\times$ 7 mils

- Recommended solder volume for bulk capacitor footprint is 16,200 cubic mils. For example:

  Stencil opening using uniform stencil = 105 $\times$ 180 $\times$ 8 mils

- Fiducial apertures may be eliminated from stencil if not required by equipment.

Technician Requirements

Requirements for the technician include:

- Perform solder paste performance criteria (viscosity), unless performed by vendor.
- Determine registration or alignment of solder paste to circuit pattern and deposition.
- Perform in-process testing (paste heights, volume, slump, and so forth.)
- Stencil cleaning

4.2.3 Equipment Requirements

Parameters

Parameters are plant specified according to individual equipment and process requirements.

Screen printers must meet minimum equipment requirements specified in EL-MF417-01.

As a guideline, the following printer settings were successfully used for both AYO and MLO MPM 2400 screen printers during the FB+ Verification test case trials.

Printer Settings	Side 1	Side 2
Tooling plate reference	NA	FB+ S2
Squeegee blade type	80	80
Snap-off	50th	50th
Squeegee travel	11 inch	3 inch
Squeegee speed	5 inch/second	4 inch/second
Squeegee pressure	15 lb	15 lb
Down stop	40th	40th

Equipment should be set up by qualified screen printer technician.

Stencil Backing Plate (Side 1)—Equipment and Product-Specific According to Module Layout.

4.3 COMPONENT PLACEMENT (SIDE 2)

After solder deposition, surface mount components are placed on module by high-speed pick-and-place system(s). Components are picked up from component feeders and moved to a designated location, aligned, oriented, and placed.

4.3.1 Material Requirements

Components

- Surface mount components unpack and visually inspect for damage.
- Transceivers

72-hour rebaking requirement—Six hours at 150°C. Refer to EL-MF417-01.

CAUTION

Tranceivers are extremely ESD-sensitive!! All precautions described in *DEC STD 067-0 Electrostatic Discharge - Sensitive Devices* shall be followed during assembly, inspection, test, and maintenance.

4.3.2 Process Requirements

This operation requires the operator to down-load component coordinate (ODF/OCF) data into placement equipment, set up component feeders, load and unload the assembled product.

All standard process precautions, handling, procedures, and safety practices should be followed.

ODF

ODF/OCF data can be obtained by importing the appropriate file

UA and MD PLO files can be copied from MSBMDA cluster node MDA.

- Addition to MDA access list requested.
  - — VSSCAD::ABRAMS
- Instructions:
  - — Set host MDA
  - — USERNAME: MDA
  - — Enter Part #: B2999
  - — Enter Revision: B01
- Information is menu driven.
- Directory may be copied over to an unprotected file.

OCF file for B2999-00 Etch rev. A1 used in confirmation trials (REFERENCE ONLY):

```
          50-PRODUCT :50-B2999-00       REV :A01
          54-PRODUCT :54-B2999-00       REV :A01
              LAYERS :10
               WIDTH :10.427
              HEIGHT :11.392
         CIRCUIT TYPE :NONSTD
        SURFACE MOUNT :Y

            CIRCUIT FIDUCIALS :
                    X          Y

      SIDE :  2  13025.00   2150.00
      SIDE :  2  12625.00  12725.00
      SIDE :  2   3200.00  12725.00
      SIDE :  2   2800.00   2150.00

                CIRCUIT SIDE  2

    PART NUMBER : 103015301             PINS :   2
REF  COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
C10  4785.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C12  4565.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C14  5185.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C16  4965.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C18  5585.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C2   3535.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C20  5365.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C22  5985.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C24  5765.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C26  6385.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C28  6165.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C30  6785.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C32  6565.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C34  7185.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C36  6965.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C38  7485.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C4   3315.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C40  3090.00  3300.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C41  3090.00  3600.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C42  3090.00  3450.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C6   4385.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10
C8   4165.00  3275.00     0.00     0.00     0.00     0.00 270  Y   CP  10

    PART NUMBER : 132382525             PINS :   2
REF       COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
R26       4250.00  3500.00     0.00     0.00     0.00     0.00  90  Y   CC  10

    PART NUMBER : 132382565             PINS :   2
REF  COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
R10  3100.00  2875.00     0.00     0.00     0.00     0.00  90  Y   CC  10
R11  3100.00  2625.00     0.00     0.00     0.00     0.00  90  Y   CC  10
R12  2990.00  2875.00     0.00     0.00     0.00     0.00  90  Y   CC  10
R21  3550.00  3475.00     0.00     0.00     0.00     0.00  90  Y   CC  10
R23  3425.00  3475.00     0.00     0.00     0.00     0.00  90  Y   CC  10
R25  4125.00  3500.00     0.00     0.00     0.00     0.00  90  Y   CC  10
R27  3300.00  3475.00     0.00     0.00     0.00     0.00  90  Y   CC  10
R7   2990.00  2625.00     0.00     0.00     0.00     0.00  90  Y   CC  10
R8   2990.00  3125.00     0.00     0.00     0.00     0.00  90  Y   CC  10
R9   3100.00  3125.00     0.00     0.00     0.00     0.00  90  Y   CC  10

    PART NUMBER : 132382649             PINS :   2
REF  COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
R1  12715.00  2864.00     0.00     0.00     0.00     0.00   0  Y   CC  10
```

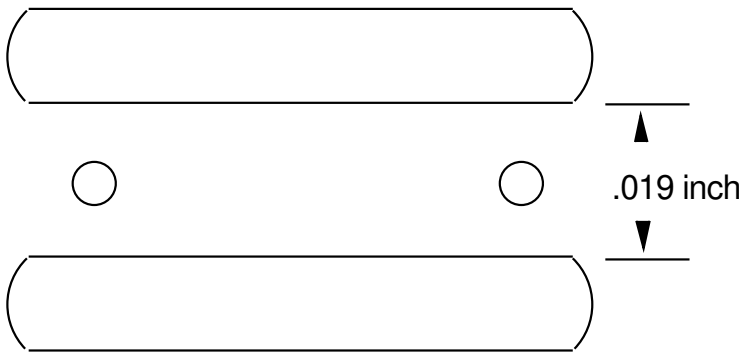
```
  PART NUMBER : 193544301              PINS :  52
REF  COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
E10  5925.00  2725.00  6160.10  2960.10  5689.90  2489.90  90  Y   SM  10
E12  6525.00  2725.00  6760.10  2960.10  6289.90  2489.90  90  Y   SM  10
E14  7125.00  2725.00  7360.10  2960.10  6889.90  2489.90  90  Y   SM  10
E8   5325.00  2725.00  5560.10  2960.10  5089.90  2489.90  90  Y   SM  10

  PART NUMBER : 193544401              PINS :  52
REF  COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
E2   3525.00  2725.00  3760.10  2960.10  3289.90  2489.90  90  Y   SM  10
E4   4125.00  2725.00  4360.10  2960.10  3889.90  2489.90  90  Y   SM  10
E6   4725.00  2725.00  4960.10  2960.10  4489.90  2489.90  90  Y   SM  10
```

Epoxy Dispense—Not recommended for FB+ corner area components.

Recommend that FB+ side 2 passive components be reflowed by infrared oven and shielded during connector wave soldering. Therefore, no epoxy dispense would be required.

Exception: Board relayout shifting FB+ components in a nonpreferred area for shielding.

Care must be taken if decoupling capacitors (10-30153-01) are epoxied, due to the close pad (.019 inch) spacing. Recommended epoxy dispense requirements are as follows:



Epoxy should be dispensed in two locations (as shown), each at approximately 75% of normal volume for that type component.

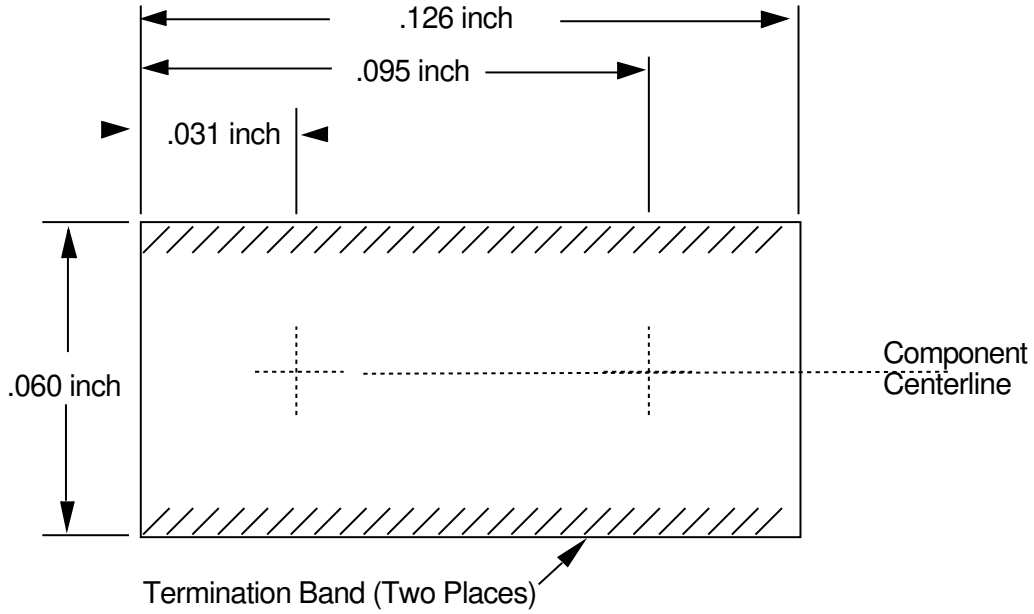
Locate two epoxy dots:

1. X direction

   Component centerline

2. Y direction

   Within 25% from each end of component. For example, component length is .126 inch $\times$ 25% = .031 inch.



Inspection

Recommend to inspection at 100% of .65-mm pitch devices for placement accuracy, following 75% lead-on-pad placement alignment requirements. Readjust component alignment, if necessary.

4.3.3 Equipment Requirements

Placement Equipment—Plant Specific

Must meet Digital's standards for placement accuracy and volume. Placement equipment systems must be capable of placing a wide range of parts from 0805 chip components to 52-pin .025-inch pitch devices.

6 SMT 8-mm tape-and-reel feeders (resistors and capacitors)
1 SMT 12-mm tape-and-reel feeder (bulk capacitor)
16-pin SOIC tube feed capability (glitch filter)
Pick-and-place capability (transceivers)
5.3 inch $\times$ 12.3 inch $\times$ 0.3 inch matrix tray

4.4 INFRARED REFLOW (SIDE 2)

The infrared process reflows solder paste on the modules. A conveyor transports the module through various heated zones at required speeds to promote proper soldering.

4.4.1 Material Requirements

No special materials required.

4.4.2 Process Requirements

Process requirements follow:

- Module profiling—Product specific. Perform standard thermal profiling for side 2 of FB+ module per volume requirements.
- No specific IR process requirements. Standard module procedures must be followed.

NOTE

Reference SMT Verification Trial reports for examples of thermal profiles successfully used for generic FB+ test cases. (See Appendix A)

- Perform IR process using standard procedures and operations for infrared reflow.

Inspection

All surface mount devices should be inspected to *DEC STD 116-9 Workmanship Standards Manual - Surface Mount* guidelines and *DEC STD 176-4 Surface Mount Printed-Wiring Board Acceptance Criteria*. Any joints not meeting criteria will be flagged, logged, and subsequently repaired.

Frequency should be 100% of tranceivers inspected.

Lead-on-pad requirements

Wetting of solder

4.4.3 Equipment Requirements

Recommend using an infrared reflow oven with forced air convection. This promotes consistent heat over the module during solder reflow process.

4.5 AQUEOUS

The next step after surface mount assembly and reflow is to remove flux residue and other contaminants from the module.

4.5.1 Material Requirements

Plant specified degreaser and cleaning solvents for specific process and equipment requirements.

4.5.2 Process Requirements

Standard module clean process for side 2.

4.5.3 Equipment Requirements

Equipment will be plant specific, and must meet required plant and Digital cleaning and safety specifications for equipment used.

4.6 SCREEN PRINTING (SIDE 1)

Side 1 FB+ module screen printing requirements are the same as side 2, except for a couple conditions. Only the exceptions will be highlighted in this section.

4.6.1 Material Requirements

Same as side 2 requirements.

4.6.2 Process Requirements

Stencil for side 1 layout.

GERBER files—Solderpaste artwork for stencil generation may be obtained by importing B2999_00_B01.ART_SP1.GRB;1 file from MDA utility.

Aperture—Recommended solder volume for bulk capacitor footprint is 16,200 cubic mils. For example:

Stencil opening using uniform stencil = 105 × 180 × 8 mils

4.6.3 Equipment Requirements

Parameters—Same as side 2 requirements.

Stencil Backing Plate (Side 1)—Equipment and product specific according to module layout. Backing plate has cut-outs to conform with module layout of components and supports module during screen printing process.

4.7 COMPONENT PLACEMENT (SIDE 1)

4.7.1 Material Requirements

Same as side 2 requirements.

4.7.2 Process Requirements

Operator will down-load side 1 component coordinate (ODF/OCF) data into placement equipment. Information may be obtained through MSBMDA cluster node MDA.

Epoxy Dispense—Not required for side 1 components. All side 1 passives and actives will be infrared reflowed.

ODF/OCF

Inspect—Same as side 2 requirements. OCF file for B2999-00 Etch rev. A1 used in confirmation trials (REFERENCE ONLY):

```
   50-PRODUCT :50-B2999-00       REV :A01
   54-PRODUCT :54-B2999-00       REV :A01
       LAYERS :10
        WIDTH :10.427
       HEIGHT :11.392
 CIRCUIT TYPE :NONSTD
SURFACE MOUNT :Y

    CIRCUIT FIDUCIALS :
            X          Y
```

```
    SIDE :  1   3201.80  12725.00
    SIDE :  1  13026.80   2150.00
    SIDE :  1  12626.80  12725.00
    SIDE :  1   2801.80   2150.00

              CIRCUIT SIDE  1

  PART NUMBER : 103015301             PINS :   2
REF   COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
C11   11261.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C13   10641.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C15   10861.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C17   10241.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C19   10461.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C21    9841.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C23   10061.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C25    9441.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C27    9661.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C29    9041.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C3    12511.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C31    9261.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C33    8641.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C35    8861.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C37    8341.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C39   12291.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C43   12741.80  3300.00     0.00     0.00     0.00     0.00   90   N   CP   1
C44   12741.80  3450.00     0.00     0.00     0.00     0.00   90   N   CP   1
C5    11441.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C7    11661.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1
C9    11041.80  3275.00     0.00     0.00     0.00     0.00   90   N   CP   1

  PART NUMBER : 103497629             PINS :   2
REF   COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
C1    12761.80  3815.00     0.00     0.00     0.00     0.00  270   N   OV   1

  PART NUMBER : 132382525             PINS :   2
REF   COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
R16    7801.80  2625.00     0.00     0.00     0.00     0.00   90   N   CC   1
R18    7801.80  2875.00     0.00     0.00     0.00     0.00   90   N   CC   1
R20    7801.80  3125.00     0.00     0.00     0.00     0.00   90   N   CC   1
R22   12401.80  3475.00     0.00     0.00     0.00     0.00  270   N   CC   1
R24   12276.80  3475.00     0.00     0.00     0.00     0.00  270   N   CC   1
R28   12526.80  3475.00     0.00     0.00     0.00     0.00  270   N   CC   1

  PART NUMBER : 132382533             PINS :   2
REF   COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
R13   11701.80 12795.00     0.00     0.00     0.00     0.00  270   N   CC   1
R14   11576.80 12795.00     0.00     0.00     0.00     0.00  270   N   CC   1

  PART NUMBER : 132382565             PINS :   2
REF   COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
R15    7926.80  3300.00     0.00     0.00     0.00     0.00   90   N   CC   1
R17    8051.80  3300.00     0.00     0.00     0.00     0.00   90   N   CC   1
R19    8176.80  3300.00     0.00     0.00     0.00     0.00   90   N   CC   1
R2    12736.80  3125.00     0.00     0.00     0.00     0.00  270   N   CC   1
R3    12836.80  2625.00     0.00     0.00     0.00     0.00  270   N   CC   1
R4    12726.80  2875.00     0.00     0.00     0.00     0.00  270   N   CC   1
R5    12836.80  2875.00     0.00     0.00     0.00     0.00  270   N   CC   1
R6    12726.80  2625.00     0.00     0.00     0.00     0.00  270   N   CC   1

  PART NUMBER : 193544201             PINS :  52
REF   COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
E1    12376.80  2725.00 12611.90  2960.10 12141.70  2489.90 270   N   SM   1
E17    8176.80  2725.00  8411.90  2960.10  7941.70  2489.90 270   N   SM   1
E3    11776.80  2725.00 12011.90  2960.10 11541.70  2489.90 270   N   SM   1
```

```
  PART NUMBER : 193544301              PINS :  52
REF   COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
E11   9376.80  2725.00  9611.90  2960.10  9141.70  2489.90 270  N   SM   1
E13   8776.80  2725.00  9011.90  2960.10  8541.70  2489.90 270  N   SM   1
E7   10576.80  2725.00 10811.90  2960.10 10341.70  2489.90 270  N   SM   1
E9    9976.80  2725.00 10211.90  2960.10  9741.70  2489.90 270  N   SM   1

  PART NUMBER : 193544401              PINS :  52
REF   COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
E5   11176.80  2725.00 11411.90  2960.10 10941.70  2489.90 270  N   SM   1

  PART NUMBER : 193569801              PINS :  16
REF   COMP X    COMP Y    FID X     FID Y    FID X     FID Y  ROT MIR INS  LYR
E16  11976.80  3405.00     0.00     0.00     0.00     0.00 270  N   SM   1
```

4.7.3 Equipment Requirements

Same as side 2 requirements.

4.8 INFRARED REFLOW (SIDE 1)

4.8.1 Material Requirements

Same as side 2 requirements.

4.8.2 Process Requirements

Module Profiling—Product specific. Perform standard thermal profiling for side 1 of FB+ module per volume requirements.

Inspect

Same as side 2 requirements.

4.8.3 Equipment Requirements

Same as side 2 requirements.

4.9 AQUEOUS (SIDE 1)

4.9.1 Material requirements

Same as side 2 requirements.

4.9.2 Process Requirements

Same as side 2 requirements.

4.9.3 Equipment Requirements

Same as side 2 requirements.

4.10 CONNECTOR ASSEMBLY/HEATSTAKING

Detailed assembly information for the 2-mm connector is provided in this segment since it is a new Digital part and a lack of current information available manufacturing sites.

Heatstaking is the connector-to-module fastening operation that melts the connector posts into formed plastic rivets, thus holding and aligning the connector to the board. This operation is performed by a heatstaking machine (DuPont MT110) using 21 heated punches to melt and form all heatstake rivets.

4.10.1 Material Requirements

Connector-to-module assembly

2-mm Connector: Connector soldertail pins are 2 mm (.079 inch) on center. Pins are held into place by a plastic wafer and registered to within .2 mm True Position (TP).

Module PTH diameter = .030 inch ±.003 inch
3 types–4 × 48 signal, 4 × 6 signal, and 4 × 2 power
2-pin variations–3.53-mm (.139 inch) tail length (.093-inch thick modules)–2.73-mm (.107-inch) tail length (.062-inch thick modules)
Material–High temperature plastic (Vectra A-130). Melting point 280°C
Alignment–Two plastic press-fit locator (x and y) pins per 4 × 6 modular section.

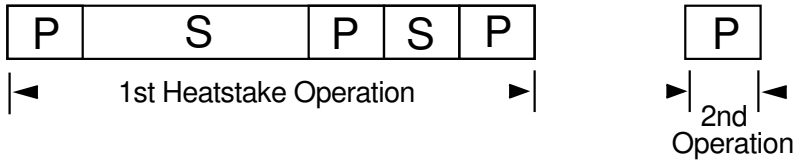
4.10.2 Process Requirements

Process requirements for the 2-mm connector follows:

1. Remove 2 mm connector from its ESD protective tube container very carefully so as not to damage or bend soldertail pins.
2. Grasp connector at the ends between thumb and forefinger.
3. Using heatstake post for pre-alignment, gently insert soldertails into module PTHs.
4. Once all soldertails have been successfully inserted, press connector firmly into module. This process is required to ensure press-fit locator pins are securely positioned (snug) for proper connector × - y alignment.
5. Visually inspect for bent or damaged soldertail pins. This inspection is performed by placing one end of the connector at eye-level and viewing down entire length of connector rows for any pins out-of-place or PTHs not protruding through.
6. Repair any bent pins with needle nose pliers. If pins cannot be repaired, replace connector section.

The DuPont MT110 heatstaking machine has the capability to form all heatstakes in one operation.

Exception: Depending on connector configuration, an uneven distribution of connectors across the module edge may require two separate heatstaking operations. For example:



Separate module setups are required for each heatstake operation.

- Center desired connector-riveting area beneath punches.
- Adjust machine parameters for each riveting operation per required settings. For example, rivet psi = 2.9 psi/stake and total psi = 79.75 psi/stake.

NOTE

Machine provides dual pressure gages with switch to quickly cycle between required setups.

Refer to Preparation and Operation of Heatstake Machine in Subhead 4.10.3 Equipment Requirements segment, for initial machine setup procedures and requirements.

The cycle of operation is:

1. Load the PWB. The PWB and connector(s) are placed into the machine work area with the unformed heatstakes pointing upwards. The alignment features on the connector underside are used to align the connectors with the machine and provide accurate registration of the connector(s)/PWB within the machine.
2. The machine-heating block/punch assembly descends upon the unformed stakes under a pressure of approximately 0.2 bar/stake. The stakes melt and start to form the rivet. This melt continues until the punches travel a specified distance that confirms the stakes have melted and are ready to be formed. There is no means of checking that the heating block has traveled a specified distance. The operator must depend on the setup parameters of the machine.
3. The pressure is now increased to 5.5 bar in order to remove any gap between the PWB and connector, and also to form the rivet head.
4. The stakes are then cooled under pressure. This cooling is achieved by blowing compressed air onto the punches after a predetermined time completion of step 3.
5. The head is retracted to remove the PWB with connectors attached.

NOTE

Steps 2 through 5 are performed automatically.

Pass or Fail Criteria

Vectra:

a. All rivet heads should have a total head formation of greater than 75%. In other words, no more than 25% of plastic material can be missing from the formed rivet after heatstaking.

b. The maximum air gap that should exist between the PWB and the rivet head should be 0.1 mm (0.004 inch). This value can be obtained by a feeler gauge. The gauge should not insert more than 1 mm (0.04 inch) beneath the head.

c. The process should not cause PWB delamination around the formed heatstakes. This process should be achieved by minimizing the time the hot punch is in contact with the PWB.

d. The finished dimension of the stake must be:

   Diameter: Less than 4.2 mm. (.0165 inch)

   Height: The protrusion height must be less than .045 inch from board surface.

e. Minor flashing or excess plastic is allowed within 4.5 mm (.177 in) diameter of rivet center.

4.10.3 Equipment Requirements

Equipment Parameters

The DuPont MT110 multiheatstaking machine has been fully characterized for operation within module assembly. The following settings are for assembling 2-mm connectors using Vectra A-130 plastic.

Table 2: MT110 Machine Parameters

Heater temperature	235°C	
Preheat time	16 Seconds	
Dwell time	1.4 Seconds	
Rivet pressure	0.2 Bar/stake	2.9 psi/stake
Cooling time	2 Seconds	
Total riveting pressure	5.5 Bar	79.75 psi/stake

Preparation and Operation of Machine for Heatstaking

1. Switch on machine. The ON switch is located on the front control panel.
2. Turn on air pressure. The air valve is located behind the filter system located on the left-hand side from front view of the machine. Correct air pressure reading on the filter Gauge is 5.5 bar.
3. Wait 40 minutes to ensure that the heating block has reached the correct temperature. The temperature of the heating block can be obtained from the temperature gauge located on the front control panel. Temperature setting: 235°C for Vectra material.
4. Check if the connector(s) are pressed firmly against the PWB ensuring there is no visible air gap between the PWB and the connector.
5. Place the PWB (fitted with the connector) in the MT110 holding area.

NOTE

Ensure the connector ribs fit into the required grooves on the MT110 PWB holding area.

6. Ensure the first connector on the PWB is positioned against the tip of the adjustable round distance pin.
7. Move MT110 PWB holding table so that the heatstakes contained on the PWB are located under the MT110 heating block. This move can be ensured by pushing the holding table firmly against the left-hand stop.
8. With both hands, press CYCLE START switches simultaneously. These are located at the side of the holding table. If the heating block remains static when switches are pressed, release switches and press again simultaneously.
9. Once the heating block has come in contact with the heatstakes the CYCLE START switches can be released.

NOTE

At any time before the heatstaking head has reached the heatstakes, the riveting cycle can be aborted by releasing the CYCLE START switches. The cycle can be restarted by following steps 7 and 8.

Automatic Riveting Cycle

After the heating block has come in contact with the heat stakes the following process is automatically followed by the MT110 machine.

Table 3: MT110 Machine Parameters

Preheat heat time	16 seconds	
Preheat pressure	0.2 Bar/stake	2.9 psi/stake
Dwell time	1.4 Second	
Rivet pressure	5.5 Bar/stake	79.75 psi/stake
Cooling time	2 Seconds	
Cooling pressure	5.5 Bar	
Reset time	40 Seconds	

Removing the PWB from MT110

Remove the PWB by moving the holding table to the left-most region and extracting the PWB.

Operational Requirements

Throughput—The machine must be capable of performing 60 assemblies per hour. This time doesn't include assembly of the connector to the PWB, but does include loading and unloading boards to or from the machine.

Robustness—On establishment of optimum operating parameters such as temperatures, pressure, time, and so forth. No tweaking of adjustment of parameters should be required in normal operating conditions. The process parameters should be independent of the PWB coplanarity.

Dimensional Integrity—Upon setup of the PWB fixturing, the process should be dimensionally repeatable under conditions experienced in a manufacturing environment. For example, the staking punches should always land on the center of the stakes within a true position of 0.4 mm diameter. This positioning implies that the PWB should be positively locked to prevent movement during the process.

Punch Contamination—The process should not cause adhesion of plastic to the punches.

Maintenance Requirements

This segment quantifies Digital's requirements for the introduction of process equipment.

Installation—The machine must be installed by DuPont's service personnel.

Maintenance—Digital maintenance personnel must be trained to debug and repair all elements of the machine including, calibration and preventative maintenance. In this case, one day's maintenance training by DuPont's qualified personnel should suffice.

Operator Training—Three Digital operators must be trained to an operational level on the machine.

Documentation—The following documents must be supplied to Digital:

Mechanical drawings and schematics
Electronic drawings and schematics
Illustrated parts breakdown diagrams and parts list
Fault diagnosis/troubleshooting guide
Full maintenance procedures and adjustments
Operators manual and instructions

Maintainability—The machine must be accessible to a maintenance technician for both troubleshooting and preventative maintenance. Meaning that all items requiring service, including cables and hoses, must be accessible by no more than removal of the machines covers.

All electrical and pneumatic lines must be labeled with a cross reference to the schematics above.

Performance—Unplanned down-time must not exceed 2 hours per a 3 month period.

Preventive maintenance intervals should be no less than 1 month or 3500 cycles, whichever is smallest. Preventative maintenance should not exceed 1 hour at this frequency.

Recommended Spare Parts—The machine is to be supplied with spare parts to support the above up time requirement.

Installation Facilities—The machine should be able to operate on 220 V ac, 50 Hz supply and use lubricated air supplied at 8 bar. The voltage for the U.S. is 110 V ac, 60 Hz, and lubricated air supplied at 116 psi.

Safety—The risk of catching hands or other limbs under the actuated head exists.

To remove the risk of catching an operator's hand or other limb under the head on the down stroke, either the head should be fully enclosed and/or two-handed safety should be employed.

Risk of Burning—The heated head and punches should be guarded to prevent the risk of burning an operator.

Electrostatic Discharge—The machine must be grounded and not contain any fabrics/materials that could be considered static generative.

Equipment With the Machine

Two heating thermocouples
Three head shims used to change to a different board thickness
Lubricant oil
Operation manual

4.11 HAND ASSEMBLY

This segment outlines the hand assembly of other FB+ through-hole components before wave or local soldering process.

4.11.1 Material Requirements

LEDs: 11-17373-00 and 11-17373-02

3-Pin Test Connector: 12-22841-01 B, 3-position 1 × 3, right angle, .156 cc, 90D

4.11.2 Process Requirements

Hand Assembly Procedure

LEDs—Assemble after heatstaking operation.

Hand place two intrusive-pin LEDs on side 1. Yellow "fault" LED (D1) and green "run" LED (D2) are placed for soldering. Gently bend leads on side 2, thereby securing LEDs to module for soldering.

3-Pin Connector—Assemble after heatstaking operation.

Unpack and place 3-pin right-angle test connector (J7), as required.

4.11.3 Equipment Requirements

None

4.12 WAVE SOLDER

Wave solder through-hole components and protect active components on side 2 by using a shielded wave solder pallet. Numerous shielded pallet configurations have been designed, developed, and successfully tested on FB+ configured board layouts.

4.12.1 Material Requirements

Shielded Pallets—The following provides a summary of FB+ shielded pallet designs:

ASO successfully designed a stainless steel pallet with Titanium shield that protects entire FB+ area and extends across the entire board width creating a through-hole component exclusion area. This pallet design may be obtained through Bob DuMais (ASO engineer).

AYO successfully designed a G10 pallet that protects the FB+ corner area (actives and passives). No through-hole exclusion zone required. This pallet is the preferred design. This design and its requirements can be obtained through Michele Jones (AYO engineer).

KAO successfully designed a pallet using EESD2000 material that protects only the active components (transceivers) and allows for passives within the corner area to be wave soldered, if desired. No through-hole exclusion zone required. This design may be obtained through Viorica Florescu (KAO engineer).

Flux—Plant specific.

4.12.2 Process Requirements

Set up solderwave equipment according to pallet and shield dimensions used. Standard solderwave procedures and operations should be followed.

Depending on solderwave equipment, solder-pot height may need adjustment to allow melted solder to reach the same height as the module board median line.

Adjust solderwave depth to allow the transceiver's shield to pass freely over the solder pot.

4.12.3 Equipment Requirements

Below are the KAO solderwave parameters that were optimized on Electrovert equipment for .093-inch and .062-inch thick FB+ test case modules. An intermediate flux (Kester) achieved best results. Mildly activated fluxes produced excess solder and increased bridging.

This information should be used as a guideline only.

Thick Module Parameters .062-Inch

Preheat profile (belt speed/preheat temperature in. - fin.)

3.0 ft./min.	600–700°F
4.0 ft./min.	700–800°F
5.0 ft./min.	800–900°F

Solder pot temperature = 480°F

Solder pot height = 3/16 inch. Height needed for shield clearance.
Solder wave depth = 3/8 inch. Difficult to correlate with a dial indicator. Smoothness of shallow lambda wave needs to be checked after height adjustments.

No component should be taller than the shield, otherwise the solder pot height and wave depth should be redefined.

Thick Module Parameters .093-Inch

Preheat profile (belt speed/preheat temperature In.-Fin.)
3.0 ft/min / 800–900°F
Solder pot temperature = 460–480°F
Solder pot height = 3/16 inch
Solder wave depth = 3/8 inch

NOTE

Refer to *Futurebus Modules—Solderwave Process Characterization* document by Viorica Florescu, for details of solderwave experimentation performed. (See Appendix A)

Future development is underway to redesign pallets so that standard solder pot heights and wave depths can be used.

4.13 LOCAL (WENESCO) SOLDERING

Module layouts designed with dense active and passive components on side 2 may be difficult to wave solder properly. Layout may dictate a need for localized soldering for through-hole components. The following provides a summary of the 2-mm connector local (Wenesco) soldering characterization for .062-inch and .093-inch thick FB+ modules.

Modules were characterized using a Wenesco M70 freestanding selective soldering station. However, information can be transferred to the M300 volume unit with in-line flux and Calrod preheat stations.

4.13.1 Material Requirements

Alpha 809 RMA flux is recommended.

4.13.2 Process Requirements

Flux connector PTHs before preheat.
Inspect connector PTHs after assembly for the following defects:

Open solder joint	No solder in PTH
Insufficient solder	Cannot see bottom of void
Shorts or bridges	Bridging of two or more pins
Excess	Cannot see pin outline
Peaks	Sharp point on a joint

4.13.3 Equipment Requirements

Tooling

The following tooling requirements are specific to each product design layout.

Solder Nozzle Base Plate

20-inch × 20-inch interchangeable plate (1018 cold-rolled steel) that bolts to the Wenesco solder pot unit.
The base plate orifices designed to allow a supply of molten solder into nozzles for each component soldering area.
Design requirements can be obtained through Mike Schraft (TME engineer).
Fabrication in qualified machine shop.

Solder Nozzles

Standard nozzles (303 stainless steel).
Fastens directly to the base-plate.
Acts as a fountain providing solder to through-hole components.
Nozzle openings directly correspond to PTH component outline.
Design requirements can be obtained through Mike Schraft (TME engineer).
Fabrication in qualified machine shop.

Module-Locating Pallet

20-inch × 20-inch composite Delmat material (CDM)
Mounted to base-plate tooling pins.
Secures module
Locates and aligns PTH soldering area directly above nozzles.

Design requirements can be obtained through Mike Schraft (TME engineer).
Fabrication in qualified machine shop.

Fabrication—EMC Domestic, Inc., 4059 Skyron Drive, Doylestown, PA 18901

Module-to-Nozzle Distance (Height) Requirement

.060-inch ±.010 inch from bottom of board to top-edge of nozzle.

Fluxer Base Plate and Nozzles

Material G10
Same design as soldering tooling
Equipment settings

Characterization successfully determined local soldering capability for numerous configurations of the 2-mm connector. The following parameters have been optimized:

Board Preheat Temperature—For 10 minutes

Molted Solder Temperature—490°F

Solder Dwell Time

13 seconds for all connectors in one shot
10 seconds for 192-pin connectors
7 seconds for 24-pin connectors

Air Pump Pressure—Equipment and product specific.

- Varies from machine to machine
- Dependent on quantity of nozzles present and solder volume needing to be pumped.
- Adjust and set dwell air-pressure at a point where molten solder is just coming through bottom of nozzle orifice.
- Adjust and set air pump pressure at a point where molten solder is just overflowing the nozzle and provides a smooth soldering surface at the wave.
- Quick rise and fall of molten solder is preferred for best results.

Refer to *Wenesco Owner Manual* for operators instructions.

4.14 AQUEOUS

4.14.1 Material Requirements

Plant specific.

4.14.2 Process Requirement

Plant specific.

Depending on aqueous machine and module carrier being used, water entrapment within the 2 mm connector housing may take place. If this condition occurs, a hot air drying process may be required.

4.14.3 Equipment Requirements

Plant specific.

4.15 REPAIR (If Required)

4.15.1 SMT Repair

Standard repair practices and procedures should be followed for surface mount components (resistors, capacitors, 50-mil, and 25-mil pitch devices)

4.15.2 Connector Repair

Repairing the 2-mm connector involves the following operations:

1. Heatstake rivet removal
2. Local desoldering/connector removal/solder removal from PTHs
3. Reassemble and reheatstake connector to module
4. Local resoldering of connector to module
5. Inspect

NOTE

Refer to *FB+ Connector Repair Feasibility Document*, author Janak Brahmbhatt, December 18, 1991 for alternate Digital Services repair process. (See Appendix A)

4.15.2.1 Heatstake Rivet Removal

A fixture was successfully developed to remove plastic heatstaked connector rivets cleanly from mounting holes. This method was developed in order to protect module from damage. The reason for removing the heatstaked rivets is to replace a possible bad connector with a good one. The heatstake removal process has more than one subassembly. These assemblies consist of the following elements:

Base Plate

20-inch × 28-inch aluminum plate
Adjustable angle rails (allows frame to slide back and forth)
Aluminum drill holding block
Fabricated: Machine shop (Digital)
or

C & C Machine Company
15 Hale Street
Haverhill, MA 01830

Module-Holding Fixture

Aluminum frame (adhesived felt material on bottom)
Sliding and locking module hold-down bars
Fabricated: Same as above

Drill Press (Small Table Top)

Mounted to base-plate
.178-inch diameter drill bit (versus .081-inch heatstake hole)
Can be ordered through: Edmund Scientific Inc., NJ.

Drill Guides

24-pin and 192-pin aluminum guide that mounts onto connector before drilling.
Contains hardened drill bushings .081-inch ID that locate directly over heatstake rivets.
Uses connectors ribs as alignment feature

4.15.2.2 Rivet Removal Process Steps

The rivet removal process steps follow:

1. Place drill guide on connector to be removed.
2. Place module/drill guide into module-holding fixture and slide in board hold-down bars locking and securing board.
3. Place and locate module-holding assembly on base-plate.
4. Adjust angle rails parallel to each other.
5. Adjust and set drill depth to penetrate through board and into connector housing .010 inch. For example, board thickness is .093 inch + .010 inch = .113 inch drill depth.
6. Slide module fixture assembly so the first rivet to be drilled is directly beneath drill bit.
7. Turn drill ON, then lower bit through bushing and drill out plastic rivet.
8. Slide assembly into next position and repeat operation.
9. When completed, remove module from fixture, guide from module, and brush away loose/excess plastic.
10. Inspect for hole damage.

NOTE

Refer to *Metral Connector Assembly and Repair Process for Futurebus Products* document for further details. (See Appendix A)

4.15.2.3 Desoldering/Connector Removal/Solder Removal

Once all appropriate heatstake rivets have been removed, desolder and remove connector using a Wenesco localized soldering system. The connector and solder removal processes is being characterized and combined into one operation.

Originally, the Heated Air Blow-out System was characterized for the desoldering process. However, recently a new system that uses vacuum to remove solder from PTHs has been very successful in test cases. This vacuum system will be used for most other products and to be consistent with other sites; recommended for FB+ products as well.

The solder removal equipment consists of four pieces:

Vendor	Description	Quantity	Total Cost
Parker Hardware	[1]Aero-motive tool balancer #62157	1	$46.97
Deprag Inc.	Swivel boom	1	$209.00
W. W. Grainger	Dayton hang up vacuum #2Z988	1	$179.42
McMaster Carr	Teflon lined flexible hose #5497K52	1	$136.93
Axis Technologies	Custom fabricated Teflon vacuum Nozzle	1	$400.00
Maynard machine	Fastener removal tool	1	$269.00
	Modified fasteners	12	$ 84.00
	[1]Vacuum in/out adapter	2	$366.75
	Total		$1692.07

[1]Denotes only one used on prototype system. Additional electronic materials will also be needed to retrofit the Wenesco Controls. Materials will be specific for a particular machine type/model. A generic print and parts list are currently being documented.

NOTE

Contact Randy Robuccio, DTN 289-1574, M/S APO01-2/E2, NAVIER::ROBUCCIO for additional information on solder removal vacuum system.

Process

1. Setup Wenesco machine parameters and tooling for appropriate connector configuration, as described in assembly section. Reduce dwell time by three seconds for each connector size. For example, 10 seconds for 192 pin and 7 seconds for 24 pin.
2. Activate solder pump so that solder rises and de-solders connector pins. Remove connector and position vacuum hood in preparation of solder removal.
3. Once solder recedes, allow two seconds for vacuum to activate, then lower hose and press hood onto board and slide across PTH field until vacuum shuts off.
4. Inspect

   Check PTHs to ensure majority of the holes are cleaned. If more than 5 PTHs for a 192-pin connector are still plugged with solder, repeat operation.

   Stubborn plugged PTHs connected to ground may need to be cleaned using two soldering irons on each side and a solder sucker. However, solder irons have a tendency to damage PTHs, at times and this procedure should only be used as a last resort.
5. Re-assemble and reheatstake connector to module

   Use same procedure as described in Heatstake Assembly segment.
6. Local resoldering of connector to module

   Use same procedure as described in Connector Soldering segment.
7. Inspect

   Use same inspection procedure as described in Connector Soldering segment. It must meet same requirements.

4.16 BULKHEAD ASSEMBLY

A bulkhead (handle) fixture was successfully developed to enable a manufacturing operator to eyelet the FB+ bulkhead to an FB+ module within the required tolerances set forth by the IEEE/EIA committee.

4.16.1 Material Requirements

Bulkhead (70-28727-01) generic assembly. Some redesign will be required to conform to product requirements.

Eyelet (90-06745-00)

4.16.2 Process Requirements

Assembly procedure follows:

1. Slide module into fixture frame grooves to the fixed stop point.
2. Placed bulkhead (handle) in required area and secure by rotating retention nuts. This applies positive pressure to the bulkhead/ module/connector assembly.
3. Fasten bulkhead to module through normal eyeletting process.
4. Remove module/bulkhead assembly by untightening retention nuts and sliding module out of frame.
5. Module can be inspected by measuring dimension between the underside of the the handle and the front face of the 2 mm connector. This dimension should be 296.85 mm ±0.35 mm.

NOTE

Refer to *Process Documentation for Futurebus Handle Fixture* (See Appendix A)

4.16.3 Equipment Requirements

Equipment consists of a 315 mm × 320 mm × 6.5 mm aluminum module retaining frame and two retention nuts for securing bulkhead to module.

Fixture can be obtained from Design I.D. Automation LTD. Plassey Technological Park, Limerick, Ireland.

Fixture can also be fabricated in Digital model shop by obtaining drawings.

5 EQUIPMENT COSTS

The following provides estimated equipment costs required to build FB+ module.

SMT	Quantity	Cost
Screen print backing plate	1	$ 300
Screen print stencil	2	$ 600
Miscellaneous tooling		$ 500
Component feeders	6	$ 24,000 (if req.)
Through Hole	**Quantity**	**Cost**
Heatstake machine (DuPont MT110)	1	$ 18,500 (Buy) $ 5,000 (Lease)
or		
(AT & T MT130)		$ 25,000 (Buy) $ 7,000 (Lease 1st year) $ 6,200 (2nd—5th year)
Note: Costs include preparation, installation, and spare parts.		
Solderwave pallet	12	$ 1,600
Miscellaneous tooling		$ 500
Wenesco (Flux, preheat, and solder)	1	$ 35,000
Solder nozzles	5	$ 1,500
Flux nozzles	5	$ 1,500
Nozzle base-plate	5	$ 1,000
Module locating pallet	5	$ 1,500
Solder removal blow-out system	1	$ 3,500
(Controller, arm, hoods, and so forth...) or		
Solder removal vacuum system	1	$ 1,000
(Vacuum, controller, balancer, and so forth...)		
Heatstake rivet removal system	1	$ 400
Bulkhead (handle) fixture	1	$ 400

6 DESIGN FOR MANUFACTURING

The following information highlights assembly and module layout issues and concerns that were observed throughout the FB+ module assembly development activities. These issues and concerns directly affected the manufacturability of the FB+ B2999 module. Also, this segment briefly highlights the activities involved in resolving the concerns. Most of these concerns were rectified by the Assembly Team within the Assembly Forum. However, other issues required experimental evaluations. Details for each of these experiments can be located in their respective reports listed in the *Related Documents* appendix.

6.1 ISSUES, CONCERNS, AND RESOLUTIONS

Legend: I = Issue, C = Concern, R = Result/Resolution

6.1.1 Surface Mount

6.1.2 Connector-to-Transceiver Spacing

I Initially, the layout provided a spacing of .100 inch between pad edges of the 2 mm connector plated through-hole (PTH) to transceiver pad edge.

C Distance (.100 inch) may be too close. No required distance standard is available for these types of components.

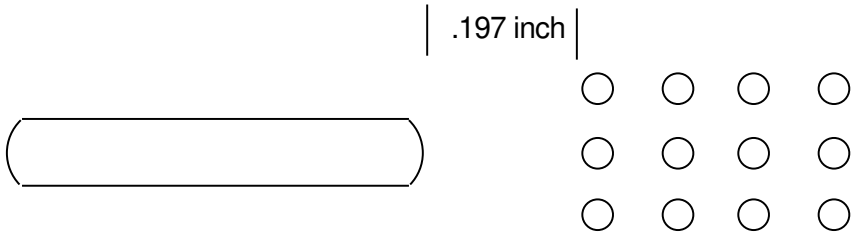
C1 PTHs may be reflowed during hot gas repair process of the transceivers.

C2 Side 2 Transceivers needing to be shielded during wave soldering process may experience shadowing or dry joints (PTHs), due to surface tension of the shield being so close.

C3 Side 2 Transceivers needing to be shielded during wave soldering process may experience reflow of surface mount soldered joints, possibly causing defects.

C4 Discoloration of the connector or soldertail wafer.

R Experiments were performed and it was determined that .187 inch is the distance (PTH pad edge to SMT pad edge) required for proper assembly and repair of components. Information was input to FB+ Module Layout group and module footprint was changed to reflect .197-inch spacing between PTH and SMT pad edges.



R1 Experiments performed in NIO, used test cases with surface mount components at staggered distances from the connector PTHs. These experiments analyzed several effects of hot gas repair, such as:

- Effect on 2 mm connector solder wicking
- Effect on 2 mm connector wafer
- Effects on surface mount solder joints from connector soldering and de-soldering operations

Refer to *Metral Connector Assembly and Repair Processes for Futurebus Products* document, Chapter 8.

R2 Experiments performed in Kanata (KAO) and Clonmel (KLO), using a wave solder shield designed by KLO, showed no ill effects on transceivers, after running through a wave solder.

Additional tests were performed in ASO and MLO, using a pallet designed by ASO, also showed no problems.

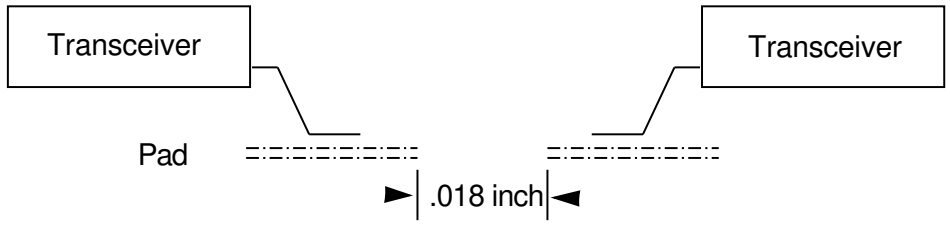
Still another series of tests were performed in MLO, using a pallet design for COBRA product, and these showed good results as well.

R3 Experimentation performed in KAO did not show a problem.

R4 A change in the low temperature (POCAN) plastic to the high temperature (Vectra A-130) solved this problem. The NIO experimentation, using the Vectra plastic connector, showed no discoloration after soldering assembly or repair.

6.1.3 Transceiver-to-Transceiver Spacing

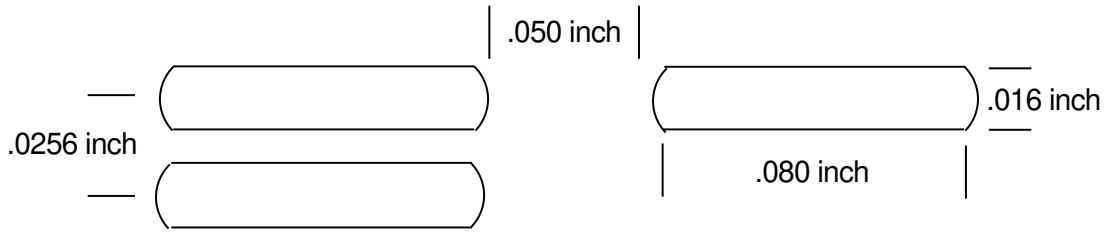
I Initially, the module layout provided a distance of only .018 inch clearance from the edge of one transceiver pad to the edge of another transceiver pad.



C May reflow or damage adjacent pad or lead during repair.

R Analysis of pad dimensions was performed in NIO to determine what the appropriate outline should look like for ideal solder joint configuration, especially the heel fillet radius. The calculations, at the same time, allowed for the pads to be shifted slightly away from each other, resulting in a .050 inch spacing. Experiments were performed and determined that this clearance does not cause a problem.

Figure 2: Redesigned Transceiver Footprint



NOTE

Product groups should institute a *DEC STD 030-10 Module Manufacturing Standard - Footprint Design for Surface Mount Technology* waiver when using this configuration. (See Appendix A)

6.1.4 Bulk Capacitor

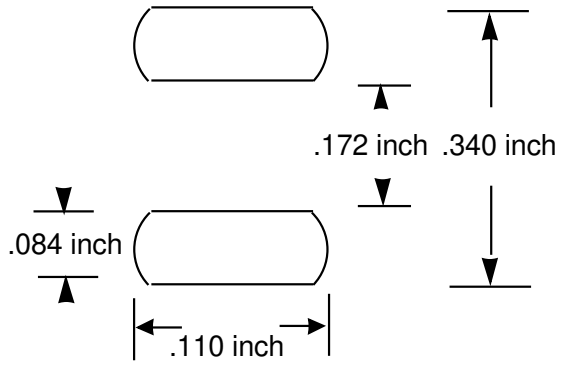
I This part was changed to a new general purpose part, which had a smaller terminal band at each end. Module manufacturing was not familiar with this design.

No pad configurations available at time. New pad design being proposed by DEC STD 030-10 was extremely tight (small pads) and was not being evaluated with test cases.

C Tolerancing of new DEC STD 030-10 is very tight for component placement equipment, which could result in component off or partially off pads, thus resulting in tomb stoning or open joints.

R Calculated new (wider) pad configuration, with a proven footprint design model and verified bond quality through test cases.

Figure 3: New Bulk Capacitor Footprint



NOTE

Product groups should institute a DEC STD 030-10 waiver when using this configuration.

6.1.5 ESD Strip (side 2)

I ESD strip is located on side 2. Unable to re-layout module change to side one.

C Tin-lead/lead plated ESD strip may collect solder balls, if exposed to wave solder during connector soldering process.

R Redesigned wave solder pallet to cover ESD strip.

CONNECTOR

6.1.6 New Fastening Process! Heatstaking with Alignment Pins

C Connector heatstaking new process at Digital.

R Development effort successfully characterized heatstaking equipment and process.

6.1.7 New Connector PTH/Soldertail Pin Configuration

C .030-inch versus .038-inch PTHs, .079-inch versus .100-inch PTH grid. New to Digital.

R Reliability model and X-segmenting was performed on PTHs.

R Solderability characterization was performed.

6.1.8 Connector Insertion

C Connector soldertails were not very robust and may stub or bend during module insertion.

R Worked with Interconnect Team on improvement of soldertail true position. Performed connector-to-module tolerance analysis.

6.1.9 Soldering Process

Double-sided active components and their close proximity to the connector PTHs. Also, shield could cause dry solder joints, due to shadowing effect.

C Which soldering process is best, localized or wave with shielded actives?

R Performed development and comparison evaluation for both local and wave solder methods.

6.1.10 Water Entrapment After Aqueous Cleaning

I Kanata (KAO) observed water entrapped in 2 mm connector after aqueous cleaning test modules.

C May cause ICT test problems, if water remains in connector. May cause corrosion in long term.

R Determined long and short term effects of entrapped water solution to be negligible. Depending on type of aqueous equipment is in use water entrapment may be present. For these situations, a drying or blowout process is recommended.

6.1.11 Repair/Removal of Connector

C Best way to remove connector rivet? Snip-off with cutters, Snap-off (break it manually), or drill it out?

R Performed evaluation of all three methods and determined that drilling is safest and cleanest process.

6.1.12 Handle

6.1.13 IEEE/EIA Inspection Requirement (Bulkhead-to-Connector)

C How do we hold the tolerance?

R Developed, Designed, and Fabricated a handle fixture, which holds the bulkhead in position during eyeletting process.

6.1.14 Board Cut

I Tight board tolerances dictated by the EIA

C Board dimensions need to be maintained tighter than conventional manufacturing board-cutting equipment can achieve. Therefore, the possibility of plants procuring expensive equipment (approximately $85K.) to achieve this requirement.

R Plants have agreed to eliminate machine insertion process steps requiring tooling strips. Boards can be obtained prerouted from vendor. Hastings boards are already obtained this way, Cobra and Laser will follow the same path.

7 DEVELOPMENT ACTIVITIES

7.1 PROJECT BREAKDOWN

The FB+ Module Assembly development project was divided into the following activities:

- Surface mount (SMT) assembly and repair process verification
- Develop and characterize connector assembly process
  - — Characterize heatstake process
  - — Characterize local solder process
  - — Verify wave solder process
  - — Solderability experiment
- Develop and Characterize Connector Repair process
- Develop and Characterize Bulkhead (Handle) Assembly process
- Provide Communication Vehicle for manufacturing sites
- DFM (Design for Manufacturing)

7.2 PROJECT ACTIVITIES

This segment summarizes information for each FB+ module assembly development activity, including; Objective(s), Summary of work, Results, and Conclusion(s). More detailed information for these activities can be found in their individual development reports listed in the *Related Documents* appendix.

7.2.1 Surface Mount Assembly and Repair

Objective:

The objectives of the surface mount assembly and repair development activities are twofold:

1. Resolve any open assembly issues and concerns with the FB+ corner layout through experimentation, evaluation, or the Assembly Forum.
2. Verify SMT design and assembly/repair capability of FB+ module for volume build by:
   - Develop a test plan collectively (Manufacturing Assembly Team).
   - Execute the SMT test plan in two manufacturing sites (ASO and AYO).
   - Compare results and determine or recommend the best assembly process.
   - Verify the recommended process by performing a confirmation trial at an alternate site.

Summary of SMT Work:

Layout Evaluation—The FB+ B2999 module layout and components were evaluated collectively by the Module Assembly team within the bounds of the Assembly Forum. All SMT assembly/repair issues were addressed and individual experiments, development, and evaluations performed. Refer to head 5 for SMT issues and evaluation results.

Assembly Verification Trials—Using the information acquired from evaluations, the Assembly Team generated a process strategy for the proposed module layout. Test vehicles and components were obtained to execute and verify the process and FB+ module layout.

The SMT verification activities were performed at three module manufacturing site locations, Augusta (ASO), Ayr (AYO), and a confirmation run at MLO. Resident team members performed SMT assembly trials using their site's volume module assembly line. Modules were inspected after each process step.

SMT activities included, but were not limited to:

Inspection

Component(s)
Packaging
New footprints
Module

Screen Printing (Sides 1 and 2)

Documented solderpaste parameters
Stencil comparison between AYO and ASO
Documented machine settings
Performed solderpaste measurements
Documented quality results

Component Placement

Documented requirements
Checked OCF
Checked component carriers
Checked component placement

Reflow

Documented oven profiles
Documented quality results

Aqueous

Cleaned
Inspected

Repair

Verified replacement process

Assembly Equipment

The following is a breakdown of assembly equipment used within each SMT verification site:

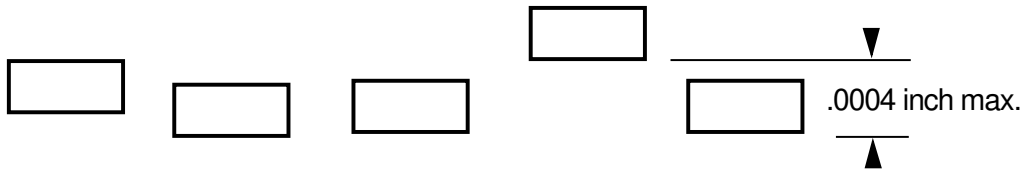
Equipment	AYO	ASO	MLO
Screen print	MPM 2400	Fuji GSP-II	MPM 2400
Chipshooter pick and place	Siemens SP120	Fuji CP-III	Quad
25-mil pick and place	Siemens HS180	Fuji IP-I	Adept
Reflow oven (I/R convect)	Electrovert 500 LCV	SPT 770X	Vitronics
Aqueous cleaner	Hollis Polyclean II	Stoelting[1] CBW-224	Hollis
Repair	Zevac DRS21 Metcal	Metcal solder iron	Metcal solder iron

[1] With microdroplet kit

SMT Results

This segment summarizes all of the SMT verification results. The results of each site have been combined and are presented as one outcome, unless specified otherwise. Refer to individual verification reports, listed in the appendix, for additional detailed data.

Inspection—Tranceivers were inspected for nonparallelism (coplanarity) of leads (lead-to-lead) using a comparator measuring system.



Results were very good! All leads maintained parallelism to each other to within .0004 inch maximum.

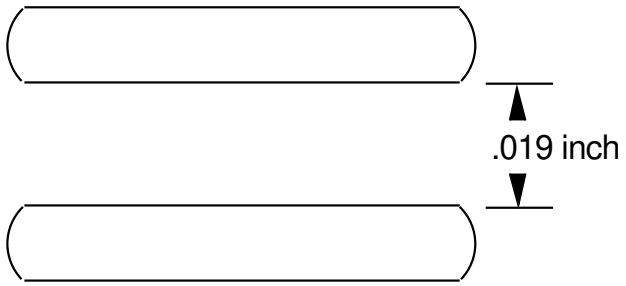
Transceiver matrix trays were not shipped dry packed or within normal shipping containers for the purposes of these trials. However, components were still observed undamaged.

Glitch filters were not supplied but identical SOIC component packages were substituted.

Measurements were taken and confirmed all of the new dimensions for spacing issues in question, including:

Redesigned transceiver footprint
New bulk capacitor footprint
Transceiver-to-connector pad edge spacing

The tight spacing (.019 inch) between the two pads for decoupling capacitors (10-30153-01) was viewed as a potential risk for shorts. However, no problems surfaced during any of the trials.



Module was measured and found to be within EIA specifications. Test case modules were manufactured by ACT.

A quantity of five B2999 (10-layer) generic test case modules were allocated for both Augusta (ASO) and Ayr (AYO) and six for the MLO confirmation runs. These modules included only the footprint for the B2999 double-sided FB+ layout.

Screen Printing (Sides 1 and 2) - A stencil comparison was done between AYO and ASO to determine if one variation was better than another. Stencil recommendations were made to each site. However, sites preferred to procure stencils using their own vendors and standard stencil configurations. The only requirements were that the stencils be stainless steel and ensure that solderpaste volumes for transceivers pad (5,880 cubic mils) and bulk capacitors (16,000 cubic mils) were consistent.

Stencil configurations are as follows:

Feature	AYO	ASO	MLO
Material	Stainless steel	Stainless steel	[1]
Type	Uniform 8 mil	Step 10/5 mil	[1]
Aperture cut	Laser	Acid etch	[1]
Aperture type	Rectangle	Oval	[1]
Aperture sizes			
Transceivers	.011 inch × .066 inch	.014 inch × .070 inch	[1]
Bulk capacitor	.105 inch × .180 inch	.107 inch × .180 inch	[1]

[1]Same as AYO. AYO and MLO have same screen printer. AYO's same stencil and machine settings were used.

Results showed both stencils performed equally.

Solderpaste Type

- Fine grain solderpaste (Kester 229) was used in all cases
- 63/37; flux type RMA
- Particle size 25–38
- Viscosity 900 Kcps

Machine Settings

Plants set up screen printers according to individual machine specifications for component technology used. Plant settings, such as blade dirometer, snap-off, speed, pressure, down-stop, can be referenced in each verification report.

Support plates for side 2 screening were fabricated to ensure module stability during screening operation.

Stencil Alignment

The AYO and MLO MPM 2400 screen printers do not have automatic vision correction capability, so board fiducials were not used. Alignment was performed manually. Stencils had fiducial holes which deposited paste on the component fiducials. These needed to be cleaned before placement for placement machine vision system recognition.

ASO's Fuji screen printer (with vision) used local circuit level fiducials for module alignment with stencil. Circuit level fiducials on the stencil were partially drilled and filled with black epoxy for vision recognition. Component level fiducials were not used.

Stencil alignment and setup went smoothly with no difficulties observed.

Solderpaste Parameters

Solderpaste print quality was checked and height measurements were performed to ensure consistent quality of paste deposition, including solderpaste volumes.

Table 4: Average Paste Heights (inches)

	AYO	ASO	MLO
25-mil components Side 1	.0092	.0053	.0088
Paste volume (cubic mils)	6679	5194	6388
Side 2	.0088	.0063	.0097
Paste volume (cubic mils)	6388	6174	7042
Note: Recommended volume using model = 6257 cubic mils			
Bulk capacitor			
Side 1	.0092	n/a	.0085
Paste volume (cubic mils)	17,388		16,065

Overall results of screen printing produced good results. After initial alignment and setup, all prints were acceptable.

Slight warpage was noticed on some modules after first reflow. However, it was still acceptable.

Component Placement

Component feeders were mounted.

Tape feeders–8 mm and 12 mm

Feed tubes for 16 pin SOICs

Installed matrix trays in placement equipment tray feeder and transceivers were pick-and-placed directly from tray. All parties cited the trays as good packaging for the transceivers.

ODF data needed to be reprogrammed by all sites to match each machine's requirements. This process was cited as a normal function.

Problems were noticed in AYO and ASO:

- Capacitors 90 degrees in wrong direction. Refer to *DEC STD 030-5 Module Manufacturing Standard — Module Assembly and Component Insertion Rules*.
- ESD resistor footprint pads were in wrong direction. DEC STD 030-5 requires all resistors on side 2 to be facing the same direction, if parts are to be wave soldered.
- Onsertion codes were missing for transceivers. APPIX to be updated.

Operators resolved the problems on-line. Problems were noted and sent to design layout team for corrective action. No ODF problems were observed later for the confirmation trials.

All components were inspected for misalignment. All components were successfully placed in AYO and ASO with no defects, once data was corrected. MLO cited two transceivers as being placed incorrectly, due to operator alignment error. These were easily corrected.

Reflow

All sites used I/R convection ovens to reflow SMT components. Module profiles for side 1 and 2 were developed using M.O.L.E. thermal measurement system through thermocouples to board. Resultant profiles did not differ from each other.

The density of components located in one corner was an initial concern for profiling. However, no profiling problems surfaced at any of the sites. Profiles used were within the guidelines of mass reflow specifications.

All modules were inspected using *DEC STD 116-0 Workmanship Standards Manual - Introduction* criteria (such as solder bridging, misalignment, defective joints, and so forth.) Transceivers were inspected to a 75% lead-on-pad criteria.

The results showed good wetting on all but one component lead. This defect was located very close to a fiducial and was most likely caused when solderpaste was wiped away.

Aqueous

Modules were cleaned and inspected using a zero ion contamination meter. Contamination levels were well within specifications.

Repair

Transceivers, glitch filters, and bulk capacitors were successfully removed and replaced. No special equipment was required for this repair process.

Reliability Tests

Pull-testing was performed on transceiver leads to verify joint strength for new footprint. Testing was done in the NRO evaluation laboratory. Results were good with all leads meeting joint strength specifications.

SMT Conclusions

All major SMT assembly issues were addressed and resolved.

Small lot builds were performed using three separate module assembly lines at AYO, ASO, and MLO using various assembly equipment. No major problems were observed during any of the SMT assembly and repair verification builds for the FB+ module.

The verification trials confirm the surface mount manufacturability of the FB+ module.

7.2.2 Connector Heatstaking Characterization

Development effort was required for the selected 2 mm connector, which uses a new-to-Digital heatstaking fastening process. It is basically a plastic hot-riveting operation that secures the connector to the module.

Objective

The objective is to fully characterize the FB+ 2-mm connector heatstaking process and equipment. The process must produce a product that meets IEEE/EIA specifications for positional tolerance and backplane insertion requirements.

Summary of Heatstaking Characterization Work

A FB+ connector staking process selection was performed by the Canadian Technology Center (CTC) that compared three types of staking equipment (hot air, hot punch, and ultrasonic). The recommended option was the DuPont MT110 Gang Heatstaker for a high temperature plastic (Vectra A-130 LCP) connector.

The DuPont MT110 Heatstaking machine was fully characterized in the KLO facility using Hastings product. The characterization included both low temperature (POCAN) and high temperature (Vectra) connectors. Characterization factors included, but was not limited to, the following criteria:

- Design for experiments (D.O.E.)
- Optimization of machine parameters

Factors:	Heater temperature	Preheat time
	Dwell time	Punch pressure

- Results were based on:

Rivet formation	Surface finish	Rivet shear/tensile
Aesthetics	Delamination	Connector/PWB Alignment

- Throughput capability of 60 assemblies per hour, not including manual assembly of connector to module.
- Dimensional integrity of equipment
- Ease of operation
- Maintainability
- Safety

Results of Characterization

Determined parameters for POCAN material. However, reliability testing determined that POCAN connector heatstakes could not meet shear and tensile requirements. Two-mm POCAN connectors will not be qualified.

Determined optimized parameters for connectors using Vectra material.

Heater temperature	235°C	
Preheat time	16 Seconds	
Dwell time	1.4 Seconds	
Rivet pressure	0.2 Bar/stake	(2.9 psi/stake)
Cooling time	2 Seconds	
Total rivet pressure	5.5 Bar/stake	(79.75 psi/stake)

Expected rivet head formation using outlined parameters is 97%. Below is a summary for Vectra material:

% head formation	Pull strength
100	150 N
90	130 N

50% rivet head formation was the predicted minimum value that the heatstake could still meet pull strength (90 N) requirements. However, 75% head formation will be the recommended lower limit.

Age testing showed no significant difference in pull or shear strength.

All other results met their specified process, tolerance, and operational requirements.

Conclusion

The MT110 heatstaking machine was characterized and produces a connector-to-module assembly that meets IEEE/EIA specifications.

Predicted pull and shear strengths for Vectra material were substituted into the Cpk formula, arriving at the following values:

Pull testing– Cpk index equals 1.65 equating to < 1 PPM

Shear testing–Cpk index equals 2.71 equating to < 1 PPM and near < 1 PPB

7.2.3 Verify Connector wave soldering Process

Two soldering processes, wave and local (Wenesco), for FB+ modules have been analyzed. The purpose is to determine which is best for FB+ assembly. This segment outlines the wave solder process work.

Objectives

1. Determine the solderwave operating windows for .062-inch and .093-inch thick boards.
2. Verify that the current thermal impedance, 60/10 inch × inch heat relief pads applied to one or two reference planes, is satisfactory.
3. Verify solderwave pallet shield used to protect side 2 actives during wave solder operation.

Summary of Solderwave Work

The experiment used 33 test modules (20 of .093 inch and 13 of .062 inch) with a mixture of low (POCAN) and high (Vectra) temperature 2-mm connectors.

Evaluation analyzed the following solderwave areas:

Method

- Flux deposition
  Application
- Preheating
- Solder wave
  Velocity
  Turbulence/smoothness

Material

- Flux material
  Composition
  Specific gravity
  Activation
  Contamination
- Solderwave material
  Composition
  Contamination
- Board profile
- Material
- Thickness
- Components density
- Component type

Machine

- Belt speed
- Belt height
- Belt angle
- Preheating temperature(s)
- Solderwave temperature
- Solderwave height

Operator

Measurement

- Visual inspection
- Pull strength measurement
- Material laboratory investigation

- Cross segment
- X ray laminography

Environment

- Humidity
- Temperature

A shielded wave solder pallet designed by Clonmel (KLO) was used in experimentation to determine:

- Feasibility of wave soldering modules with FB+ actives on side 2. Shield covered only the transceivers to allow soldering of passive components.
- Board travel direction. Which direction should board pass through wave to eliminate "shadowing" effect or dry PTHs, due to shield's surface tension.

The confirmation run used a slightly different pallet/shield designed by ASO, which covered the entire FB+ corner. This design allows for all FB+ SMT components to be reflowed in the I/R oven.

Results of Solderwave Experimentation

KAO Electrovert solderwave parameters were optimized for both the .093-inch and .062-inch thick FB+ test case modules.

Module parameters .062-inch thick:

Preheat profile (Belt Speed/Preheat Temp. In.-Fin.)

3.0 ft/min / 600 to 700°F
4.0 ft/min / 700 to 800°F
5.0 ft/min / 800 to 900°F
Solder pot temperature = 480°F

- Solder pot height = 3/16 inch. Height needed for shield clearance.
- Solder wave depth = 3/8 inch. Difficult to correlate with a dial indicator. Smoothness of shallow lambda wave needs to be checked after height adjustments.

No component should be taller than the shield, otherwise the solder pot height and wave depth should be redefined.

No problems with PTH double reference planes.

Boards .062-inch thick had excellent results with no defects.

7.2.4 .093-Inch Parameters

Problems were observed on first trials due to stainless steel shield absorbing heat. Temperature varied as much as 126°C from one edge of the connector to the other. New shield was ordered using EESD2000 material and trials redone.

.093-Inch Thick Module Parameters

- Preheat profile (Belt Speed/Preheat Temp. In.-Fin.)
  3.0 ft/min / 800 to 900°F
- Solder pot temperature = 460 to 480°F

- Solder pot height = 3/16 inch
- Solderwave depth = 3/8 inch

NOTE

Refer to *Futurebus Modules—Solderwave Process Characterization* document by Viorica Florescu for details of solderwave experimentation performed. (See Appendix A)

Future development is underway to redesign pallets so that standard solder pot heights and wave depths can be used.

AYO has also designed an FR4 pallet shield for the COBRA I/O board with good success.

Experiments verified travel direction of module should be with connector parallel with belt and perpendicular to wave. Shield Does not hamper solder flow to board PTHs. Some bridging was observed when connector was traveling parallel to the wave.

Conclusion

Parameters for KAO's Electrovert solderwave machine were optimized for FB+ .062-inch and .093-inch thick modules.

Verified current 60 $\times$ 10 thermal impedance is satisfactory. PTH with double-reference plane performed well.

Successfully verified solderwave pallet with shield for FB+ actives and active/passive components.

7.2.5 Characterize Connector Local (Wenesco) Soldering Assembly and Repair Process

Localized soldering can provide or supply solder to specific board areas where through-hole components and connectors are present. With the module fixtured, solder is pumped-up through strategically located nozzles (fountains) beneath the board, thereby providing solder only to those locations desired.

The benefits of a localized soldering process are:

- No wave. No shielding required for active components.
- wave soldering difficulties if many actives are present.

Objective

Develop and determine operation windows for localized (Wenesco) soldering.

- Designing orifice nozzles, tooling, pallets, and so forth
- Investigation of solder removal for repair
- Determine heatstake removal process
- Calculate Sigma capability

Summary of Local Soldering Work

Designed and fabricated .062-inch and .093-inch thick test case modules for experimentation.

Designed and fabricated Wenesco solder nozzles, solder base plate and board-locating pallet.

Developed and performed D.O.E. Taguchi experiments to define soldering parameters for connector assembly and repair.

Performed experiments to determine parameters for all combinations/configurations of connector layout.

Performed solder removal study and determined feasibility by co-designing and evaluating solder removal equipment.

Designed and fabricated heatstake rivet removal fixture, then determined feasibility.

Performed reliability assessment on PTHs using model.

Performed cross-sectioning confirmation trials of PTHs exposed to thermal cycles at every process step, including multiple repair.

Summary of Results for Localized Connector Soldering Assembly/Repair

Designed and fabricated Wenesco solder nozzles, solder base plate, and board-locating pallet complete with drawings. Nozzles needed to match exactly with connector PTH area to prevent solder from overflowing onto surface mount components.

Developed and performed D.O.E. Taguchi experiments to define Wenesco soldering parameters for connector assembly and repair..

Optimized soldering conditions for .062-inch and .093-inch boards assembling full row of connectors:

Board preheat temperature:	100 ± 5°C
Solder temperature:	490± 5°F
Solder dwell time:	13 seconds (10 Seconds actual)
Pump air pressure:	* 1.5 psi start
	* 3.5 psi final

Pressure settings listed were optimized for a specific Wenesco machine. Confirmation trials determined that solder pump air pressure (psi) was difficult to control and at times did not create a smooth solder wave at specified pump settings.

Best results can be achieved by some initial setup before soldering. Pressure should be adjusted for each operation, so wave rises quickly and forms a smooth wave at peak with a slight overflow and no turbulence.

All other settings, such as preheat, dwell, solder temperature, should be set as recommended.

Co-designed and fabricated solder removal equipment consisting of:

Air electrical control system
Solder removal arm
Solder removal blow-out hood
Incoming air heater

Characterization was performed for 24-pin and 192-pin connectors and resulted in no defects when parameters were set and operation performed correctly. Confirmation trials agreed with results when operation went smoothly.

However, the solder removal blow-out system is not currently finalized for manufacturing use. Additional development is needed such as secured hood, additional arm alignment feature, and so forth, to make this system more robust.

Also, a new vacuum system was experimented with during the confirmation trials with excellent result. The vacuum system appears to be more forgiving and easier to use. The LASER program is presently evaluating the system and will probably be the system of choice.

Designed and fabricated rivet removal fixture and successfully performed feasibility trials for heatstake rivet removal. Results showed that using this process removes heatstaked rivets and does not damage the module.

The equipment consists of:

- Base plate
- A module-holding fixture (slide)
- Small drill and bit (.078 inch diameter)
- Hole-locating drill guide (attaches to connector)

With board securely fixtured, operator manually lowers drill bit into a hole-locating fixture, which guides drill through a bushing directly over rivet center. Rivets are drilled out of heatstake holes completely allowing for easy connector removal during desoldering process.

Digital Services successfully performed a feasibility evaluation for the 2-mm connector repair process, using equipment common to most Customer Services sites (Airvac PCBRM-10 soldering station). The study also reviewed various flux types, which showed much better results when using a standard RMA flux (Alpha 611) than with that of a no-clean type (Multicore X3304).

Performed reliability assessment on PTHs using model.

This study was conducted to predict upfront the effects of solder temperatures on the connector PTHs. The study was done using a finite element model that calculates molten solder thermal cycles to failure for PTH/PCBs. Model results are shown in Table 5:

Table 5: FB+ PTH Reliability Predictions (Pad Diameter = 0.050 inch)

	Solder Temperature		NF, Cycles to Failure		
Case #	(°C)	(°F)	Barrel	Knee	Interconnect
1	215	430	715	19	98
2	232	460	276	11	54
3	250	490	61	7	31

Confirmation trials included actual cross-sectioning of PTHs exposed to thermal cycles at every process step, including multiple repair. During confirmation build process, one module was removed after each thermal process step and stored for cross-sectioning. Results are as follows:

Board	Thermal Process	Results	Within Specification
1	Bare (none)		Yes
2	Two passes I/R	Small traces of resin recession	Yes
	+		
3	Local solder assembly	Small traces of pad lifting and rotation.	Yes
		Small traces of resin recession	
		Small traces of copper dissolution	
4	Solderwave assembly	Small traces of resin recession	Yes
		Small traces of hole wall pull	
	+		
5	Once local repair	Resin recession solder void on layer 1 and 2 (due to board misalignment)	Yes
6	Two - three repairs	Bad copper dissolution	No

NOTE

Refer to *Repair Evaluation of a Futurebus Connector/PWB System.* (See Appendix A)

Conclusion:

Characterization of 2-mm connector assembly and repair processes for .062-inch and .093-inch boards was successful. This process has been proven to be a viable option for FB+ 2-mm connector assembly (soldering).

A heatstake rivet removal process was successfully developed. Heatstaked pins were removed completely without damaging module. No defects.

A solder removal process was developed proven feasible obtaining six sigma level for defects. This process was the first successful implementation for solder removal. However, other development efforts (vacuum solder removal) in progress appear to have improved on this process and needs to be reviewed more closely. It would be a goal for FB+ to standardize on one process.

Digital Services also performed evaluations on FB+ 2 mm connector repair using an Airvac PCBRM-10 soldering machine. The feasibility study indicated that the process was capable of removal and replacement of the connector.

Results of every repair evaluation effort show concern with using soldering irons or PACE tools to remove solder from unplugged PTHs. Repeating solder removal (blow-out or vacuum) process is the best method, and soldering irons should only be used on stubborn PTHs connected to ground.

7.2.6 Development of Bulkhead (Handle) Assembly Process

Objective

Provide a process to ensure tolerance between connector face and bulkhead levers, required by IEEE/EIA specifications.

Summary of Bulkhead (Handle) Process Development Work

A module-holding fixture was determined as the best way to ensure IEEE/EIA tolerances.

Designed, developed, and fabricated a handle fixture to maintain specified dimension (296.85 mm, ± .35 mm, between connector face and injector lever.

Numerous revisions were made to the original fixture design before a final design was agreed upon. The fixture was designed for simplicity and ease of use. For example:

The module slides into the fixture frame grooves to a fixed stop.
Handle is placed in required area and secured by rotating retention nuts.
Bulkhead is then fastened to module through normal eyeletting process.
Fixture is then removed by untightening retention nuts.

Conclusion

A handle fixture was successfully designed to enable a manufacturing operator to eyelet the FB+ bulkhead (handle) onto a FB+ B2999 module and keep the required tolerances.

NOTE

Refer to *Process Documentation for Futurebus Handle Fixture*. (See Appendix A)

7.2.7 Estimated Process Capabilities

The following outlines Defect, Sigma, and/or Cpk data obtained from the development activities using small sample sizes of test cases. The results provided were calculated and determined by the individuals responsible for each development activity.

OPERATION	Total Number of Joints	Total Number of Defects	95% Con. Int (ppm)	Sigma Level
		SMT		
Screen print S1	2540	1	0 - 2205 ppm	4.4 - 6+
Component placement S1	2540	0	0-1179	4.5 - 6+
IR reflow S1	2540	0	0 - 1179	4.5 - 6+
Screen print S2	2160	0	0-1386	4.5 - 6+
Component placement S2	2160	0	0 - 1386	4.5 - 6+
IR reflow S2	2160	0	0 - 1386	4.5 - 6+
Aqueous	4700	0	0 - 637	4.7 - 6+
Wave solder	930	2	268 - 4090	4.15 - 4.85
		Connector Assembly Process		
Connector assembly	3840	4	260 - 2630	4.4 - 5.0
Connector repair	5886	15	1600 - 4200	4.1 - 4.5
Heatstake removal	166	0	0 - 17900	3.5 - 6+
Solder removal	3744	0	0 - 800	4.6 - 6+

Heatstaking pull testing 1.65 Cpk <1 ppm

The predicted pull strength for Vectra was substituted into Cpk formula.

Heatstaking shear testing	
The predicted shear strength for Vectra was substituted into Cpk formula.	2.71 Cpk <1 ppm
Handle Assembly	3 - 6+ sigma

8 CONNECTOR-TO-MODULE TOLERANCE ANALYSIS

Objective:

A tolerance analysis was performed to determine the capability of assembling 2-mm connectors to the FB+ module board, and if necessary, to highlight areas for improvement.

Summary of Work:

Dimensional analysis was performed on both the connector soldertails and module plated-through-holes (PTHs). This data was then extrapolated using the RMS formula to determine if any interference exists.

The analysis was based on the following:

- Worst-case tolerances
- EIA and Digital drawings
- EIA and Digital dimensions and tolerances
- Connector & PTH true position (TP)
- Soldertail radius intersects PTH at 45 degrees
- No soldertail stubbing during insertion

Step	Description	Data (mm)
PWB:		
1.	PTH diameter	0.75 ± 0.08
2.	PTH TP	0.20
3.	Heatstake hole	2.05 +0.10/-0.00
4.	Heatstake hole TP	0.15
Connector:		
5.	Heatstake post	1.95 +0.00/-0.05
6.	Heatstake post TP	0.05
7.	Soldertail width	0,3706 at 45 degrees
8.	Soldertail TP	0.20

Calculation by TP:	
0.75 - 0.08 - 0.20 = 0.47	0.37 + 0.20 = 0.57
2.05 - 0.00 - 0.15 = 1.90	1.95 + 0.05 = 2.00
Sum 2.37	Sum 2.57

Tolerance interference at 45 degrees

2.37 - 2.57 = (-) 0.20 or radial interference = 0.2/2 = 0.1

Alternatives to improve connector-to-module assembly:

a. Solder-tail
   - Reduce tip radius
   - Reduce symmetry tolerance tip to body

b. Solder-tail hole
   - Increase PTH diameter
   - Decrease tolerance of location by using a functional datum from heatstake hole(s)

c. Datums
   - Use/clarify existing functional datum per EIA specification
   - Add functional datum in Y axis

Table 6: TOLERANCE ANALYSIS FB+ SOLDER-TAIL

Dimension/Description	Tolerance ±	Tolerance sq.
1. PTH, soldertail	0.08	.0064
2. TP PTH	0.10	.01
3. Hole, heatstake	0.05	.0025
4. TP heatstake hole	0.075	.005625
5. Diameter, heatstake post	0.025	.000625
6. TP post	0.025	.000625
7. Maximum diameter of tip envelope 45 degrees		
8. TP soldertail	0.10	0.01
	Sums W.C. 0.455	Sum Tolerance (sq) .035775

RMS = .0358 (Square root) = .1891

1.7 $\times$ .1891 = .3215

1.9 $\times$ .1891 = .3593

NOTE

Refer to *Assembly of Connector Receptacle to Module PWB*, by Jack Pennell. (See Appendix A)

Conclusion:

As part of the Intermatability Study for the FB+ 2 mm connector system, a portion of that study focused on the Module to Receptacle placement, such as insertion of the solder tails into the module board PTHs.

The calculations dated 10/14/91, were based on the EIA-IS-64 specifications and Digital Drawing Dimensions and Tolerances at that time. The results of that analysis indicated a solder tail stubbing condition, when the PTHs were at worse case tolerances. Therefore, another analysis was performed, incorporating dimensioning and tolerancing improvements

agreed upon by Engineering and Manufacturing which, after rerunning the calculations, resulted in a worse case condition where the radiused tip of the solder tail contacted the PTH at 22 degrees. In addition, statistical tolerancing methods indicated that the tail would use **clear** the PTH hole.

The DFM team agreed that those dimension and tolerance improvements, as defined by a Design Template, dated 11/19/91 by J. Pennell, would be incorporated into the FB+ User's Guide.

APPENDIX A REFERENCED DOCUMENTS

A.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00030-05	*DEC STD 030-5 Module Manufacturing Standard - Module Assembly and Component Insertion Rules*
EL-00030-10	*DEC STD 030-10 Module Manufacturing Standard - Footprint Design for Surface Mount Technology*
EL-00067-00	*DEC STD 067-0 Electrostatic Discharge - Sensitive Devices*
EL-00116-00	*DEC STD 116-0 Workmanship Standards Manual - Introduction*
EL-00116-09	*DEC STD 116-9 Workmanship Standards Manual - Surface Mount*
EL-00176-04	*DEC STD 176-4 Surface Mount Printed-Wiring Board Acceptance Criteria*
EL-ENPCB-01	*PC Board Engineering Handbook - Standard Circuit and Finger Details*
EL-MF417-01	*Surface Mount Technology Reference Manual - 2 Volume Set*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

A.2 Other Digital Documents

Document Number	Document Title
A-SP-B2999-00-0	*Futurebus+ Control Drawing*
APS1233430000000	*Digital Purchase Specification - Connector, Receptacle, Power, Right Angle, 2 mm Grid*
APS1233431000000	*Digital Purchase Specification - Connector, Receptacle, Signal, Right Angle, 2 mm Grid*
APS1233432000000	*Digital Purchase Specification - Connector, Header, Shrouded, Press Pin, Miniature, 2 mm Grid*
APS1233433000000	*Digital Purchase Specification - Connector, Header, Shrouded, Press Pin, Signal, 2 mm Grid*
APS1233434000000	*Digital Purchase Specification - Connector, Header, Straight, Double Row, Surface Mount Compatible, 0.025 Square Pins on 0.100 Centers*
	FB+ Connector Repair Feasibility Document, author Janak Brahmbhatt, 18 December 1992
	Metral Connector Assembly and Repair Processes for Futurebus Products
	Process Documentation for Futurebus Handle Fixture
	Futurebus+ Modules - Solderwave Process Characterization, by Viorica Florescu
	Repair Evaluation of a Futurebus+ Connector/PWB System
	Assembly of Connector Receptacle to Module PWB, by Jack Pennell

A.3 Other Documents

Document Number	Document Title
EIA IS 64	*EIA Interim Standard 2-mm, Two-Part Connector*
IEEE 1301.1	*Detailed Standard for a Metric Equipment Practice for Microcomputers Using 2-mm Connectors According to IEC and Convection Cooling*
IEEE P986.2	*Physical Layer and Profile Specifications*
	Wenesco Owner Manual

A.4 Ordering Information

Documents listed in subhead A.2 Other Digital Documents may be obtained through the Assembly Team members listed in subhead 2.1.

Following are the sources for documents not available from Standards and Methods Control.

- ANSI, IEC, and ISO Documents
  American National Standards Institute (ANSI),
  1430 Broadway, New York, NY 10018,
  Telephone (212) 354-3300 x479
- Electronic Industries Association (EIA),
  2001 Eye Street, NW,
  Washington, DC 20006, USA
- Digital purchase specifications may be obtained from:
  Central Specification Control Systems (NRO-5/M2), or the SPOC System
- Digital engineering drawings may be obtained by contacting Engineering Information and Image Services.

APPENDIX B RELATED DOCUMENTS

B.1 EL-Class Digital Documents

EL-Class Number	Document Title
76-65330-00	*Airvac Module Rework System - Process Operator Procedure*
76-65334-00	*Pace Desoldering System - Process Operator Procedure*
EL-00265-00	*DEC STD 265-0 Module Rework and Repair Standard Procedures*
EL-MF757-00	*Futurebus+ PWB/Module General Design Specification*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

B.2 Other Digital Documents

Document Number	Document Title
KL-0001-1283	*MT110 Operating Procedure*
	Futurebus Connector Staking Process Selection
	Feasibility Evaluation for Repairing Metral (Female) Connector of FB+ Test Case Board
	FB+ Modules–Solderwave Process Characterization
	Pad and Stencil Designs for FB+ 25-Mil Devices
	MT110 Heatstaking Characterization Report
	Metral Connector QVT Materials Characterization

B.3 Ordering Information

Documents listed as Other Digital Documents may be obtained from the Assembly Team members listed under subhead 2.1.

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